

Summary Report

Derive Entities Emissions Testing

April 12, 2016

Submitted to:

U.S. ENVIRONMENTAL PROTECTION AGENCY
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EPA Contract No. EP-W-12-007
EPA WA-2-1

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EXECUTIVE SUMMARY

In October and November 2015, a compliance inspection team consisting of staff from EPA and EPA's contractor, Eastern Research Group, Inc. (ERG) conducted emissions tests using electronic control module (ECM) tuners manufactured by Derive Entities on diesel and gasoline engines. Derive Entities is the parent company of several subsidiaries including Bully Dog Acquisition, LLC (Bully Dog) and SCT Performance, LLC (SCT). This report summarizes dynamometer emissions testing performed by EPA and ERG using Bully Dog's Diesel GT tuner (PN: 40420) and SCT's X4 Powerflash tuner (PN: 7015) on a model year (MY) 2012 Ford F-250 test vehicle with a 6.7 liter Ford Powerstroke diesel engine and a MY 2013 Ford F-150 with a 3.5 Liter Eco boost gasoline engine, respectively. The test results confirm that the Bully Dog 40420 tuner, when installed on a MY 2012 F-250 with a 6.7 liter Powerstroke diesel engine, causes nitrous oxide (NO_x) emissions to nearly triple on the Federal Test Procedure (FTP) and exceed the applicable emissions standard for this engine. The test results also confirm that the SCT 7015 tuner alters the 3.5 Liter Ford EcoBoost engine's operational design but does not increase regulated exhaust emissions on this vehicle application over the test cycles used. Further, the manufacturer of these tuners has not provided EPA any emissions test results demonstrating that this tuner does not adversely affect emissions.

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A compliance inspection team consisting of staff from EPA and EPA's contractor, ERG, investigated SCT and Bully Dog for manufacturing and selling potential defeat devices for on-highway engines. The inspection team purchased SCT and Bully Dog ECM tuning devices, installed modified calibrations on test vehicles using the tuners, and performed emissions testing. The EPA and ERG traveled to EPA's National Vehicle and Fuel Emissions Laboratory (NVFEL) the weeks of 26 October and 2 November 2015 to conduct emission testing on a model year (MY) 2012 Ford F-250 test vehicle with a 6.7 Liter Ford Powerstroke diesel engine and a MY 2013 Ford F-150 with a 3.5 Liter EcoBoost gasoline engine. The purpose of this testing was to identify which engine controls are altered by the SCT and Bully Dog tuners and how use of these tuners affect emissions of regulated pollutants.

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This report is organized as follows:

- Section I provides the background on Derive as a business, EPA's investigation of Derive, and the purpose of this testing.
- Section II describes the purchases of the Bully Dog and SCT tuners that were tested.
- Section III provides descriptions of the test vehicles, tuner installation, testing procedures, and quality assurance and other documentation.
- Section IV provides the testing results including on-board diagnostics (OBD) data, live engine data, and emissions data.
- Appendix A contains photographs taken during the investigation. Photographs are referenced in the report as Photograph [#].
- Appendix B is a table containing a chronological order of emissions testing activities performed by ERG, EPA, and Ford.
- Appendix C contains miscellaneous email documentation.
- Appendix D contains the raw emissions test data from EPA's NVFEL.
- Appendix E contains dynamometer coefficient documentation from EPA's NVFEL.
- Appendix F and G contain ERG's analysis of live engine data logged during testing.
- Appendix H contains screenshots of internet forums related to Bully Dog tuner customers who have complained about DPF regeneration.

I. INVESTIGATION BACKGROUND AND PURPOSE OF TESTING

As the business is currently structured, Derive is the parent company to several subsidiaries including, but not limited to, SCT Performance LLC (SCT) and Bully Dog Acquisitions LLC (Bully Dog). ERG

collectively refers to the business as “Derive” where appropriate in this report. Below is a general list of products that Derive manufactures and sells.

- Electronic Control Modules (ECM) Tuners
- Custom Tuning Software (SCT Advantage III)
- Custom Fleet Tunes

The purpose of the testing described in this report was to evaluate how the ECM tuners that Derive manufactures and sells may affect emissions. Specifically, EPA’s goal was to evaluate if the modified calibrations installed by the tuners cause the vehicle to exceed exhaust emission standards for which the test vehicles were certified to meet. Secondly, EPA’s goal for this testing was to evaluate the relative change in emissions from the test vehicle when using modified calibrations installed via a tuner compared to the stock calibration (i.e., baseline).

These tuners are devices that plug into a vehicle’s on-board diagnostic (OBD) data link connector (DLC) (i.e., port) and then can be used to “flash” the ECM with a modified calibration (i.e., tune). All Derive tuners come with pre-loaded calibrations manufactured by Derive but can also support “custom” tunes manufactured by other companies. Each tuner comes with multiple pre-loaded tunes that are compatible with different vehicle and engine models and MYs.

During this testing, the EPA and ERG focused on testing pre-loaded tunes (i.e., no custom tunes) with two specific tuner models: the Bully Dog GT Platinum Diesel tuner (PN: 40420) and the SCT X4 Powerflash tuner (PN: 7015). ERG refers to these tuners as the Bully Dog 40420 tuner and SCT 7015 tuner for the remainder of this report. Testing was performed on two specific test vehicles: a MY 2012 Ford F250 with a 6.7 liter Powerstroke diesel engine and a MY 2013 Ford F150 with a 3.5 liter EcoBoost gasoline engine. The modifications the tuners make depend on the vehicle and engine model and MY on which they are installed. Therefore, the effect these tuners may cause on emissions are likely to be different for other vehicle and engines models and MYs.

In general, there are two types of calibrations:

- *Emissions equipment-present calibrations:* These calibrations modify engine parameters such as fuel injection/spark timing, air to fuel ratio, torque management, and other parameters to optimize power and fuel economy. Such modifications may adversely affect emissions but do not require the emission control devices (e.g., EGR, DPF, SCR) to be rendered inoperative or to be bypassed. EPA’s goal is to determine what engine parameters these types of calibrations alter and if these alterations adversely affect emissions.
- *Emissions equipment-removed calibrations:* These calibrations render inoperative or bypass emission control devices (e.g., EGR, DPF, SCR) in the engine calibration in addition to modifying engine parameters such as fuel injection/spark timing, air to fuel ratio, torque management, and other parameters to optimize power and fuel economy. EPA’s goal is to determine if the tuner renders inoperative or bypasses emission control devices and if these alterations adversely affect emissions.

The testing summarized in this report identified no evidence that the Bully Dog 40420 and SCT 7015 tuners contain pre-loaded¹ emissions equipment-*removed* calibrations for the test vehicle models² tested. However, the testing of the pre-loaded emissions equipment-*present* calibration installed by the Bully Dog 40420 tuner confirm that emissions are adversely affected (see Section IV for results). It is also important to note that these tuners are compatible with many different vehicles, engines, and MYs and the

¹ Pre-loaded calibrations are those that are manufactured by SCT or Bully Dog.

² Ford was only able to provide the two test vehicle models described in Section III.A and was unable to provide other test vehicle models for which SCT tuners are capable of disabling emission controls.

modifications made by the tuners vary for each. In fact, during other investigation activities, the EPA and ERG have determined that several of Derive's products, including the SCT 7015 tuner, can disable emission control devices on *other* vehicle and engine models. Furthermore, many of Derive's products, including the tuners discussed in this report, support installation of custom tunes that are known to disable emission control devices. This report does not discuss these areas of concern; they are described in a separate memorandum titled *TD69 – Derive Product Purchase Memorandum*.³ All the areas of concern identified during the investigation of Derive are summarized in a separate memorandum titled *TD66 – Derive Investigation Summary and CAA 208 Information Request Response Review*.⁴

II. PURCHASE OF ECM TUNERS

ERG purchased the Bully Dog 40420 tuner and SCT 7015 tuners as a typical customer would from aftermarket dealers. The following two subsections summarize ERG's purchase of the tuners, both of which were used to perform emissions testing the weeks of 26 October 2015 and 11 November 2015. A detailed timeline of tuner purchase and testing events are provided in Appendix B. Once received, ERG handled all items as evidence, completed chain-of-custody forms for each upon receipt, and properly maintained the documentation and evidence throughout the investigation. The purchases of both tuners are documented in more detail in ERG's memorandum titled *TD69 – Derive Product Purchase Memorandum*.⁵

A. Bully Dog 40420 Tuner

ERG purchased a Bully Dog 40420 tuner directly from Punch-It Performance, LLC, a company the EPA and ERG inspected on 4 August 2015. ERG was unable to take possession of the tuner that day because Punch-It did not have one in stock. Instead, the unit was shipped directly from Bully Dog Acquisitions located at 2839 Highway 39 in American Falls, Idaho 83211 to ERG's office. The total cost of the tuner was \$649. ERG received the unit on 11 August 2015. Photographs [1] through [5] show the Bully Dog 40420 tuner as received by ERG. The serial number of the tuner is 30V6S0F7L000T and the Punch-It Performance UPC code is 681018404204. Photograph [5] shows the contents of the tuner packaging:

- Tuner (PN: 40420);
- Small SD card;
- USB dongle;
- Quick reference guide;
- OBD II wire, used to connect the tuner to the OBD data link connector; and
- USB wire, used to connect the tuner to a computer for software updates from Bully Dog.

B. SCT 7015 Tuner

ERG purchased an SCT 7015 tuner directly from Punch-It Performance, LLC, a company the EPA and ERG inspected on 4 August 2015, and took possession of the tuner the same day. The total cost of the tuner was \$399. Photographs [6] through [8] show the SCT 7015 tuner as received by ERG. The serial

³ Under Contract #EP-W-12-007 Work Assignment WA-2-1 Technical Direction 69, the EPA directed ERG to purchase multiple SCT and Bully Dog products and evaluate their tuning capabilities.

⁴ Under Contract #EP-W-12-007 Work Assignment WA-2-1 Technical Direction 66, the EPA directed ERG support EPA's investigation of Derive including, but not limited to, reviewing Derive's CAA 208 Information Request response.

⁵ Under Contract #EP-W-12-007 Work Assignment WA-2-1 Technical Direction 69, the EPA directed ERG to purchase multiple SCT and Bully Dog products and evaluate their capabilities.

number of the unit is X40717156ECA5 and the SCT UPC code is 811252020001. Photograph [6] shows the contents of the packaging:

- OBD II wire, used to connect the tuner to the OBD data link connector on the vehicle;
- USB wire, used to connect the tuner to a computer for software updates from SCT; and
- SCT warranty document.

III. EMISSIONS TESTING PROCEDURES AND DOCUMENTATION

Ford Motor Company (Ford) agreed to provide EPA with two test vehicles for EPA to conduct testing to measure emissions and engine operating data when calibrations from the Bully Dog 40420 and SCT 7015 tuners are installed. The EPA and ERG traveled to EPA's NVFEL testing facility in Ann Arbor, Michigan the weeks of 26 October 2015 and 2 November 2015 to conduct the testing. EPA's NVFEL personnel performed testing and ERG provided testing oversight and installed the calibrations. The following two subsections describe the test vehicles that Ford provided for testing, along with the complete testing procedures.

A. Test Vehicles

Table 1 provides a detailed description of the test vehicles Ford provided which included a MY 2012 F-250 with a 6.7 Liter Powerstroke turbo diesel engine and a MY 2012 F-250 with a 3.5 Liter Ford EcoBoost twin turbo direct injection gasoline engine. Photographs [9] through [15] show the MY 2012 F-250 diesel test vehicle prior to any testing. Photographs [16] through [22] show the MY 2013 F-150 gasoline test vehicle prior to any testing.

Table 1. Test Vehicle Description

Parameter	MY 2012 Diesel Vehicle	MY 2013 Gasoline Vehicle
Chassis manufacturer	Ford Motor Company	Ford Motor Company
Chassis model	F-250	F-150
Chassis date of manufacture	July 2011	May 2012
Engine manufacturer	Ford Motor Company	Ford Motor Company
Engine MY	2012	2013
EPA engine family	CFMXD06.761A	DFMXT03.54DX ^b
Engine configuration	V-8	V-6
Engine size	6.7 liters	3.5 liters
Fuel	diesel	gasoline
GVWR	10,000 pounds	7,700 pounds
VIN	1FT7W2BT7CEA03971	1FTFW1ET6DFA00007
Odometer beginning of testing	52,765 miles	46,992 miles
Aftertreatment mileage ^c	52,765 miles	46,992 miles
Useful Life	120,000 miles	120,000 miles
Emissions equipment	OC, period trap oxidizer (PTOX) ^a , SCR, EGR, turbo charger (TC), Charge air cooler (CAC), direct diesel injection (DDI), OBD	2 three way catalysts (TWC), 2 heated air-fuel ration sensors (AFS), 2 heated oxygen sensors (HO2S), direct fuel injection (DFI), 2 TC, CAC, OBD

a – This system contains the DPF.

- b – ERG was unable to identify the engine label on the F-150. Ford reported it to EPA MSEB after testing (see Appendix C).
- c – Ford confirmed the aftertreatment mileage matches the odometer reading on both test vehicles (see Appendix C).

Table 2 and Table 3 show the additive deterioration factors (DF), engine adjustment factors (EAF), certification levels, and emissions standards for the two test vehicles based on certification testing. The relevant pollutants for the test vehicles include nitrogen oxides (NO_x), particulate matter (PM), carbon monoxide (CO), Carbon dioxide (CO₂)⁶, and non-methane hydrocarbon (NMHC).

- DF is a factor that represents the increase in emissions over the life of a vehicle as a result of engine and emission control device performance deterioration. Specifically, this is the increase between certification testing, when the aftertreatment system has only been used for approximately 4,000 miles, and the end of the useful life of the aftertreatment system. Engine manufacturers must add the DF to the measured emissions when determining the official certification level.
- Upward EAF is an additional factor added to the measured emissions to determine certification levels when regeneration does not occur during the testing. This factor accounts for excess emissions during DPF regeneration and only applies to diesel engines equipped with DPFs.⁷
- Certification level is the measured emissions after DFs and EAFs are applied to the measured emissions for certifications. The certification level must be less than the certified standard.
- Certified standard is the applicable standard under 40 CFR Part 86 that the certification level must meet.

Table 2. Certification Emission Levels and Standards for Engine Family CFMXD06.761A (6.7 Liter Ford Powerstroke)

Useful Life (miles)	Test	Constituent	Emission Result (g/mi) ^a	Additive DF (g/mi) ^b	Upward EAF (g/mi) ^c	Certification Level (g/mi) ^d	Standard (g/mi) ^e
120,000	FTP	CO	0.35000	0.2100	0.01000	0.6	7.3
		HC-NM	0.03280	0.0192	0.00110	0.053	0.195
		HCHO	0.00420	0	0.00010	0.004	0.032
		NOX	0.12000	0.0500	0.01000	0.2	0.2
		PM	0.00500	0.0050	-0.00010	0.01	0.02

Source: All data are available on EPA's website at: <http://www.epa.gov/otaq/crttst.htm>.

a – This is the measured emissions test result from the emissions test.

b – This factor represents the increase in emissions over the life of a vehicle as a result of engine and emission control device performance deterioration. Specifically, this is the increase between certification testing, when the aftertreatment system and engine have only been used for approximately 4,000 miles, and the end of the useful life.

c – This factor is added to the measured emissions test result when determining certification levels when DPF regeneration does not occur during the testing. This factor accounts for excess emissions during DPF regeneration and only applies to diesel engines equipped with DPFs.

d – This is the emissions levels for this engine family certified by Ford at the end of the useful life after applying appropriate DF and EAFs to the raw emission test results at 4,000 miles.

⁶ CO₂ was also measured but is not a regulated pollutant for the F-250 and, therefore, excluded from Table 2.

⁷ When regeneration does not occur during the testing, manufacturers must add upward EAFs to account for the excess emissions during regeneration. Downward EAFs are also certified for each engine family which are added when regeneration does occur. Table 2 only shows upward EAFs because ERG did not consider a test in which a regeneration occurs to be valid due to the inability to replicate two tests in which a regeneration occurs. More information on engine adjustment factors is available online at: <http://www.epa.gov/otaq/highway-diesel/workshop/420f04022.pdf>.

e – Emissions standards this engine family is required to meet at the end of the useful life after applying appropriate DF and EAFs to the raw emission test results at 4,000 miles.

Table 3. Certification Emission Levels and Standards for Engine Family DFMXT03.54DX (3.5 Liter Ford EcoBoost)

Useful Life(miles)	Test	Pollutant	Emission Result (g/mi) ^a	Additive DF (g/mi) ^b	Certification Level (g/mi) ^c	Standard (g/mi) ^d
4,000	US06	CO	0.66000	0	0.7000	11.8
		HC-NM+NOX	0.04300	0	0.0400	0.60
	SC03	CO	0.43000	0	0.4000	4.0
		HC-NM+NOX	0.04800	0	0.0500	0.44
50,000	HWFE	NOX	0.00300	0.004000	0.0100	0.07
	FTP	CO	0.68000	0.250000	0.9000	3.4
		NMOG	0.02620	0.010000	0.0360	0.075
		NOX	0.00800	0.004000	0.0100	0.05
120,000	HWFE	CREE	385.00000	1.100000	386.0000	999.99
		NOX	0.00280	0.011000	0.0140	0.090
		OPT-CREE	388.00000	1.700000	390.0000	999.99
	US06	CO	0.66000	0.630000	1.3000	19.3
	SC03	CO	0.43000	0.630000	1.1000	6.4
	FTP	CO	0.68000	0.630000	1.3000	4.2
		CREE	524.00000	1.100000	525.0000	999.99
		NMOG	0.02620	0.025100	0.0510	0.090
		NOX	0.00800	0.011000	0.0200	0.07
		OPT-CREE	527.00000	1.700000	529.0000	999.99

Source: All data are available on EPA's website at: <http://www.epa.gov/otaq/crttst.htm>.

a – This is the measured emissions test result from the emissions test.

b – This factor represents the increase in emissions over the life of a vehicle as a result of engine and emission control device performance deterioration. Specifically, this is the increase between certification testing, when the aftertreatment system and engine have only been used for approximately 4,000 miles, and the end of the useful life.

c – This is the certified emissions levels for this engine family at the end of the useful life after adding appropriate DF and EAFs to the raw emission test results at 4,000 miles.

d – Emissions standards this engine family is required to meet at the end of the useful life after applying appropriate DF and EAFs to the raw emission test results at 4,000 miles.

B. Testing Procedures

The following subsections describe the test procedures EPA and ERG followed during emissions testing:

- Section III.B.1 describes tuner calibration installation;
- Section III.B.2 describes obtaining OBD data before and after each test;
- Section III.B.3 describes obtaining live engine data during each test; and
- Section III.B.4 describes test cycle selection and test procedures.

EPA completed one baseline and one tuner test for each test vehicle, as summarized in Table 4. As shown, the Bully Dog 40420 tuner was tested on two separate occasions, referred to as “Bully Dog – Void” and “Bully Dog – Valid” in the test calibration column. This is because after the first Bully Dog test on 28 October 2015, ERG analyzed the live engine data and determined that an active DPF

regeneration occurred⁸; therefore, EPA and ERG refer to all of the tests performed on 28 October 2015 as void and do not compare the results to baseline. Section IV.B, where results from ERG’s analysis of live data is summarized, provides additional details about the regeneration that occurred. As a result, EPA performed a second test with the Bully Dog 40420 tuner installed on 10 November 2015, in which a regeneration did not occur, referred to as the “Bully Dog – Valid” calibration. ERG was not present for this test on 10 November 2015.

To prevent a DPF regeneration from occurring a second time, ERG, with the assistance of NVFEL, forced a manual DPF regeneration on the F-250 test vehicle on 3 November 2015. The F-250 test vehicle did not have a manual DPF regeneration command button in the cab but the Bully Dog 40420 tuner provided the capability to do the manual DPF regeneration. Photographs [23] through [27] shows the DPF regeneration menu option on the Bully Dog 40420 tuner before, during, and after the regeneration. There were two types of regenerations that could be forced using the tuner: stationary or mobile. The EPA NVFEL mounted the F-250 test vehicle to the dynamometer and ERG forced a stationary regeneration.

Table 4. Chassis Dynamometer Test Matrix for Testing

Vehicle – Engine	Test Calibration	Test Dates	
		Prep Date ^a	Test Date ^b
F-250 – 6.7 Powerstroke	Stock (i.e., baseline)	10/27/2015	10/28/2015
F-250 – 6.7 Powerstroke	Bully Dog – Void ^c	10/28/2015	10/29/2015
F-250 – 6.7 Powerstroke	Bully Dog - Valid	11/9/2015	11/10/2015
F-150 – 3.5 Liter EcoBoost	Stock (i.e., baseline)	11/2/2015	11/3/2015
F-150 – 3.5 Liter EcoBoost	SCT 7015	11/5/2015	11/6/2015

a – The prep date is the date EPA ran the test vehicle on the prep cycle described in Section III.B, which must occur between 12 and 36 hours before the start of the FTP test.

b – The test date is the date EPA ran the four tests described in Section III.B.4 which includes the FTP, HWFE, US06, and SC03 tests.

c – ERG determined that an active DPF regeneration occurred during this test. As a result, EPA and ERG refer to this test as void and do not compare the results to baseline.

The following describes the general procedure the EPA and ERG followed for each tuner calibration and test. Table 16 in Appendix B provides a more detailed order of test procedures.

1. ERG downloaded the calibration identifications (Cal ID), calibration verification numbers (CVNs), the status of the malfunction indicator light (MIL) and diagnostic trouble codes (DTC) from the ECM with the existing calibration installed. See Section III.B.2 for more information on what these parameters are and how ERG obtained them.
2. ERG used the tuner to install the calibration to be tested. See Section III.B.1 for the detailed procedures ERG followed for each tuner and calibration installation. ERG started the engine momentarily to allow the ECM to detect DTCs and to recalculate the CVN.
3. ERG obtained the new Cal ID, CVN, MIL status, and DTCs from the ECM with the calibration installed.
4. ERG connected the data logger to the vehicle to obtain live engine data parameters over time during testing. See Section III.B.3 for detailed procedures related to the data logger.
5. EPA performed the test procedures described in Section III.B.4.b. See Section III.B.4.a for more details on the underlying test cycles included in these test procedures.

⁸ A DPF regeneration is a process in which the soot (i.e., PM) collected by the DPF is burned off at high temperature to leave only a tiny ash residue. Active regeneration is one method that is used when there is not sufficient heat in the exhaust to convert all the carbon being collected. During active regeneration, exhaust temperatures are raised by injecting a small amount of fuel upstream of the DPF.

1. Tuner Installation

As described above, the SCT and Bully Dog tuners all come with preloaded tunes manufactured by SCT and Bully Dog, respectively. The following subsections provide specifics regarding installation options ERG selected for testing.

a. Bully Dog 40420 Tuner Installation

After the Bully Dog 40420 tuner is turned on, a menu appears with the following options: change vehicle, install download, gauge setup, diagnostics, performance testing, driving coach setup, special functions, user options, show settings, vehicle info, uninstall download (see Appendix A Photographs [28] and [29]). To install a new calibration, ERG selected the “install download” menu option shown in Photograph [30]. Table 6 shows the Bully Dog 40420 tuner installation prompts in sequential order and indicates what ERG selected for testing. Photographs [34] through [39] show screenshots for each prompt during tuner installation. Photographs [40] and [41] show the device settings on the tuner after the tune installation completed, which shows the tuner as “installed”.

During Step #1 in Table 6, ERG first attempted to select “’11-’12 6.7L Powerstroke” but received the “Error 222 – Part Number Not Supported. Update Unit and Try Again. Contact Tech Support if problem continues” prompt shown in Photograph [31]. ERG immediately hooked the tuner to a laptop computer and ran the update software that can be downloaded from Bully Dog’s website. Photograph [32] and [33] show screenshots of the software update on ERG’s laptop computer. ERG reattempted the installation process but received the same error message shown in Photograph [31]. EPA MSEB immediately contacted Ford by telephone, who stated that the stock engine calibration on the test vehicle was an updated version released in 2015 for MY 2012 vehicles. ERG then attempted to install the “’13-’15 Ford 6.7 Powerstroke” application and was successful.

Table 5. Installation Prompts for the Bully Dog 40420 Tuner on 2012 MY F-250 with a 6.7 Liter Powerstroke Diesel Engine

Step #	Prompt	Input Options	Option Selected for Testing	Photograph #
1	Vehicle Selection	<ul style="list-style-type: none"> • ’03-’07 6.0L Powerstroke • ’08-’10 6.4L Powerstroke • ’11-’12 6.7L Powerstroke • ’13-’15 6.7L Powerstroke^a 	’13-’15 6.7 Powerstroke ^b	34
2	Selected Vehicle – please verify vehicle type. Installing on: ’13-’15 Ford 6.7 Powerstroke. If this is correct press ‘Yes’	<ul style="list-style-type: none"> • Yes • No 	Yes	35
3	Install download	<ul style="list-style-type: none"> • Pre-load tune 	Pre-load tune	36
4	Do you want to remove the speed limiter or leave the stock limiter?	<ul style="list-style-type: none"> • Removed • Stock 	Stock	37
5	Is your truck a cab and chassis?	<ul style="list-style-type: none"> • Yes • No 	No	38

a – Other input options were shown in these prompt for Dodge and General Motors (GM) vehicle applications.

b – Note that Photograph [40] shows the tuner “installed” on a “’13-’15 Ford 6.7 Powerstroke” application but the F-250 test vehicle is a 2012 MY. See explanation in introductory text above Table 5.

Photograph [41], which is a continuation of the device settings that were installed, shows that all defuel options were turned off prior to testing. The Bully Dog 40420 tuner includes defueling options that presumably reduce the tuner settings if certain conditions are met. These conditions are set by the user

when turning on defueling options (e.g., if engine coolant temperature increases above a designated value). ERG ensured that all defuel options were off for testing as shown in Photograph [41].

Photograph [42] shows the main screen on the tuner after the installation process was completed. As shown in the bottom right, the “extreme” on-the-fly tune was selected. The other three on-the-fly settings were “stock”, “tow”, and “performance”. To confirm that the most recent on-the-fly setting remained when the tuner was unplugged and then plugged back in, ERG called Bully Dog technical support on 28 October 2015. ERG also confirmed this by unplugging the tuner from the vehicle with the “extreme” setting selected and then plugging the tuner back in and observing the “extreme” tune was still selected.

b. SCT 7015 Tuner Calibration Installation

After the SCT 7015 tuner is turned on, a menu appears with the following options: program vehicle, gauges/data log, vehicle functions, vehicle info, device info, device settings (see Photograph [43]). ERG first documented the device info, shown in Photographs [44] and [45], followed by the vehicle info menu, shown in Photograph [46]. To install a new calibration, ERG selected the “program vehicle” menu option shown in Photograph [43]. When ERG attempted to install an SCT calibration onto the test vehicle on 3 November 2015, the SCT 7015 tuner recognized the 3.5 Liter EcoBoost engine as shown in Photograph [48]). However, the next screen stated “General error# 110AE, additional update required. Please run auto-update” (see Photograph [49]). ERG immediately hooked the SCT 7015 tuner to a laptop computer and ran the auto-update software that was downloaded from SCT’s website. Photographs [50] and [51] show screenshots of the software update on ERG’s laptop computer. After this update, the SCT no longer reported this error and ERG was able to continue with the installation process.

Table 6 shows the SCT 7015 installation prompts in sequential order and indicates what ERG selected for testing. Photographs [52] through [64] show screenshots for each prompt during the Ford testing installation.⁹ Photograph [65] shows the device settings on the SCT 7015 tuner after the tune installation completed, which shows the tuner as “married” and with a “preloaded tune -59 - KGCTAA6”.

Table 6. Installation Prompts for the SCT 7015 Tuner on MY 2013 F-150 with a 3.5 Liter EcoBoost Gasoline Engine

Step #	Prompt	Input Options	Option Selected for Testing	Photograph #
1	Fuel Octane	<ul style="list-style-type: none"> • 87 Octane • 91 Octane • 93 Octane • 87 Octane tow • 91 Octane tow • 93 Octane tow 	93 Octane	52
2	Intake air box	<ul style="list-style-type: none"> • Stock air box • Airaid 	Stock air box	53
6	Global spark	<ul style="list-style-type: none"> • 0 degrees to -14 degrees 	0 degrees	54
3	Axle Ratio	(no Photograph take)	Stock Value	52
4	Tires Revs/Mile	(no Photograph take)	Stock Value	52
5	Speed limit	(no Photograph taken)	Stock Value (100 mph)	52

⁹ However, as shown in Photograph [63], one more error message appeared during the install which was determined to be low battery voltage. A battery charger was connected to the vehicle for several minutes to remove this error.

Table 6. Installation Prompts for the SCT 7015 Tuner on MY 2013 F-150 with a 3.5 Liter EcoBoost Gasoline Engine

Step #	Prompt	Input Options	Option Selected for Testing	Photograph #
6	Rev limit neutral	(no Photograph taken)	Stock value (4200 PM)	52
8	Idle speed drive	• 580 to 1180 rpm	Stock Value (580 rpm)	58
8	Idle speed neutral	• 625 to 1225 rpm	Stock Value (625 rpm)	58
9	Wide open throttle (WOT) shift points	• -7 to +7 mph	+ 7 mph	55
10	Adjust tire pressure monitor system cold PSI setting?	• No • 0 through 45 psi	No	57

2. OBD Scan Tool Data Procedure

After each installation of each new calibration using the tuner during emissions testing at Ford, ERG immediately removed the tuner, connected an OBD II scan tool¹⁰ to the OBD II data link connector (DLC) on the test vehicle, and obtained DTCs, status of the MIL, Cal ID, and CVN. ERG obtained this information during the testing process:

- Before installing a new calibration using the tuner;
- After installing a new calibration using the tuner and before the emissions test;
- After completing each emission test; and
- After returning the ECM calibration to stock after each test.

The following describes each one of the parameters ERG recorded during testing using the scan tool. Section IV.A summarizes the observations.

- Cal ID – The Cal ID represents the software version, which includes the engine data maps. A new calibration installation may or may not result in a new Cal ID, depending on the tuner.
- CVN – The CVN is the result of a 'check-sum' calculation performed by the OBD system using the engine data maps as inputs. If the data values have not been changed or corrupted, the CVN will always provide the same sum for a given Cal ID. If the ECM has been corrupted or any calibration values have been modified, the CVN calculation will generate an incorrect 'sum'.¹¹ ERG used this as the ultimate indicator that the tuner installed a new calibration between each test.
- DTCs – DTCs are diagnostic trouble codes that indicate a fault has been detected in one of the engine or emission control systems and indicates the system that had the fault.
- MIL – The malfunction indicator light, also known as the check engine light, is a symbol located near the odometer. The MIL indicator is amber (yellow) in color and should be illuminated for the first five seconds after the ignition key is turned on to show that the MIL light is working

¹⁰ ERG used two different OBD II scan tools during testing: an AutoXray[®] 4000 and a Nexiq Pocket IQ.

¹¹ SAE J1979 states: *Calibrations developed by any entity other than the vehicle manufacturer will generally have a calibration verification number that is different from that calculated based on the calibration developed by the vehicle manufacturer.*

properly. After startup, the light is only illuminated when a malfunction is detected following the detection of confirmed DTCs. The MIL activates when monitored operating parameters indicate an engine or emission control component failure has occurred that has the potential to cause the vehicle's emissions to exceed the certification standard by a certain threshold.

3. Live Engine Data Logging Procedure and Analysis

During testing, the EPA and ERG logged live engine operational data. After testing, ERG used the data to evaluate operating parameters that may affect emissions such as fuel injection timing, EGR flow, fueling rates, air-to-fuel ratio (AFR), manifold pressure, DPF loading, and SCR system status. The exact parameters analyzed varied by vehicle and are listed in Appendices F and G. Specific details about the data loggers used and logging procedures are described in the following two subsections.

To analyze the data, ERG calculated percentiles values (i.e., 1st, 10th, 20th, 30th, 40th, 50th, 60th, 70th, 80th, 90th, and 99th percentiles) for each parameter over identical tests using Microsoft Excel. Section IV.B provides the results of ERG's analysis. For all calculations, ERG excluded all data points logged before the vehicle speed increased from zero at the beginning of the test and all data points after the engine RPM changed to zero at the end of the test as the engine was turned off. By eliminating the data before the vehicle moved and after the vehicle stopped, ERG was able to compare data sets on an equivalent basis (e.g., same length of time and speed trace).

a. F-250 – 6.7 Liter Ford Powerstroke

For all F-250 testing, the EPA and ERG used a HEM Data Dawn Mini Logger™ data logger configured to acquire enhanced (manufacturer-specific) engine data. ERG logged the live data by connecting the logger to the OBD II DLC just prior to baseline testing and after ERG installed the new calibration and removed the tuner from the vehicle (prior to "tuner installed" testing). The list of parameters recorded for the F-250 are contained in Appendix F, along with ERG's analysis of the data. Some of the logged parameters were manufacturer-specific. Results of live data analysis are summarized in Section IV.B. The data logger activates when the vehicle engine speed (i.e., RPM) increases from zero after the engine is turned on. The data logger was set to record data at a rate of 10 hertz or 10 data points per second. The EPA NVFEL converted the data into comma separated value format and provided ERG all of the recorded data after testing.

b. F-150 – 3.5 Liter Ford EcoBoost

For all F-150 testing, the EPA and ERG used an Auterra Dyno-Scan (version 10.0.1) data logger. ERG logged the live data by connecting the logger to the OBD II DLC and then connected a laptop computer to the data logger. During operation, the data was logged directly onto the laptop computer. Some of the logged parameters were manufacturer-specific. The list of parameters recorded for the F-150 are contained in Appendix G, along with ERG's analysis of the data. Results of live data analysis are summarized in Section IV.B. Unlike the HEM Data logger, the Auterra logger did not allow the frequency rate for data recording to be manually set. The data logger logged at an approximate rate of 1 hertz or 1 data point per second.

4. Test Cycle Selection and Test Procedure

EPA's goal was to evaluate if the modified calibrations installed by the tuners cause the vehicle to exceed exhaust emission standards for which the test vehicles were certified to meet. Secondly, EPA's goal for this testing was to evaluate the relative change in emissions from the test vehicle when using modified calibration using a tuner compared to the stock calibration (i.e., baseline). The following subsections describe the test cycles performed for the purpose of meeting these goals and the specific procedures performed at the EPA NVFEL. Results from emissions tests are described in Section IV.

a. Test Cycle Descriptions

Table 7 describes the preparation (prep), FTP-75, HWFE, US06, SC03 test cycles in terms of distance, time, and number of phases within a single test cycle. All information provided in this section, including the figures provided below Table 7, are publicly available on EPA's website.¹²

- **Prep**– As required by 40 CFR Part 86, EPA NVFEL ran a prep cycle the day before each FTP-75 test. The prep cycle is the Urban Dynamometer Driving Schedule (FTP-72). It is designed to mirror city driving conditions simulating frequent starts and stops. It is described in 40 CFR Part 86 Appendix I (a) and contains two phases (505 second, 3.6 mile Phase 1 and an 867 second, 3.9 mile Phase 2). Figure 1 shows the speed trace of a single prep cycle.
- **FTP-75**: The FTP-75 is another variation of the EPA Urban Dynamometer Driving Schedule (FTP-72) and is the primary test cycle used for certification. It is derived from the Urban Dynamometer Driving Schedule (FTP-72) by adding a third 505 second phase to the test cycle following a 10 minute engine-off soak. The third phase is identical to the first phase of FTP-72. The FTP-75 is also described in 40 CFR Part 86 Appendix I (a). Prior to a the FTP-75 test, the vehicle must go through a 12 to 36 hour “cold soak” period¹³ after the prep cycle during which the engine cannot be started. Figure 2 shows the speed trace of a single FTP-75 test cycle.
- **HWFE**: The HWFE is used by EPA to determine highway fuel economy for light duty vehicles. It consists of a single phase of non-stop highway driving. Figure 3 shows the speed trace of a single HWFE test cycle which is available in 40 CFR Part 600 Appendix I.
- **US06**: The US06 test cycle, also known as the Supplemental Federal Test Procedure (SFTP), addresses the shortcomings of FTP-72. It captures aggressive, high speed and/or high acceleration driving behavior, rapid speed fluctuations, and driving behavior following startup. Figure 4 shows the speed trace of a single US06 test cycle which is available in 40 CFR Part 86 Appendix I (g).
- **SC03**: The SC03 is another variation of the SFTP but requires the use of the air conditioning (A/C) system during the test and at a lab temperature of 95°F (35°C). For this testing, EPA was unable to incorporate the lab temperature of 95°F. Figure 5 shows the speed trace of a single SC03 test cycle which is available in 40 CFR Part 86 Appendix I (h).

Table 7. Test Cycle Descriptions

Test Cycle	Description	Test Cycle Breakdown		
		Phase #	Distance (miles)	Time (seconds)
Prep	Normal city driving	Phase 1	3.6	505
		Phase 2	3.9	867
		Total test cycle	7.5	1,372
FTP-75	Normal city driving	Phase 1	3.6	505
		Phase 2	3.9	867
		Phase 3	3.6	505
		Total test cycle	11.1	1,877
HWFE	Highway driving	Only 1 phase	10.26	765
US06	Hard city and highway driving	Only 1 phase	8.0	600
SC03	Hard city	Phase 1	3.6	596

¹² Available online at: <http://www.epa.gov/nvfel/testing/dynamometer.htm>.

¹³ The room temperature during the cold soak period must be between 68 and 86 degrees Fahrenheit (40 CFR 86.130).

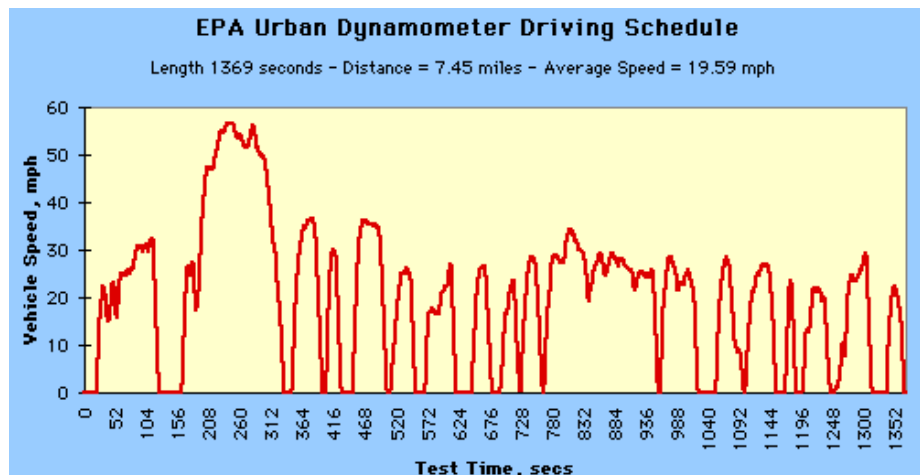


Figure 1. One Prep Cycle Speed Trace (i.e., FTP-72)

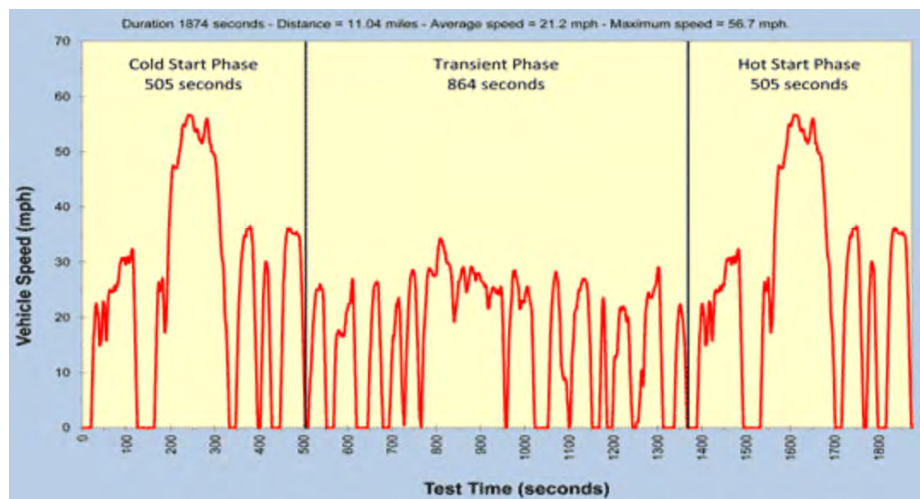


Figure 2. One FTP-75 Test Cycle Speed Trace

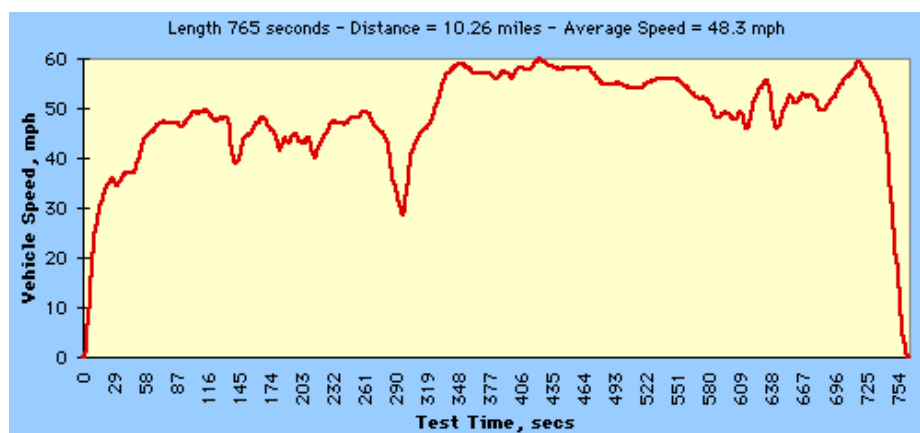


Figure 3. HWFE Test Cycle Speed Trace

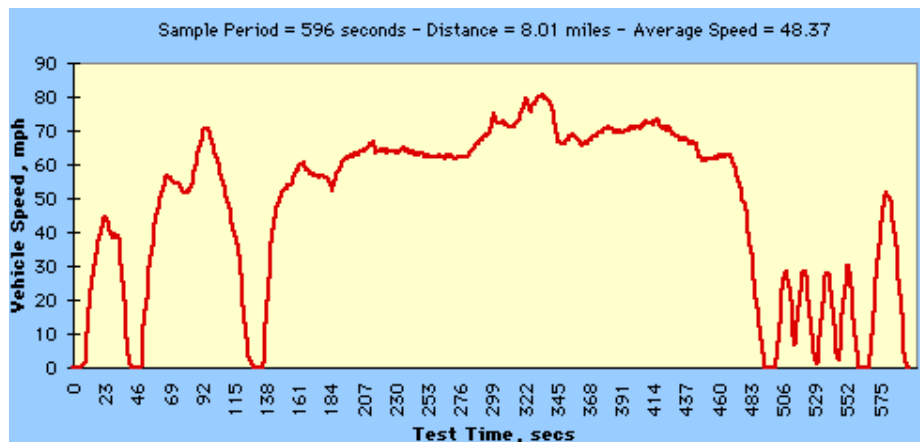


Figure 4. US06 Test Cycle Speed Trace

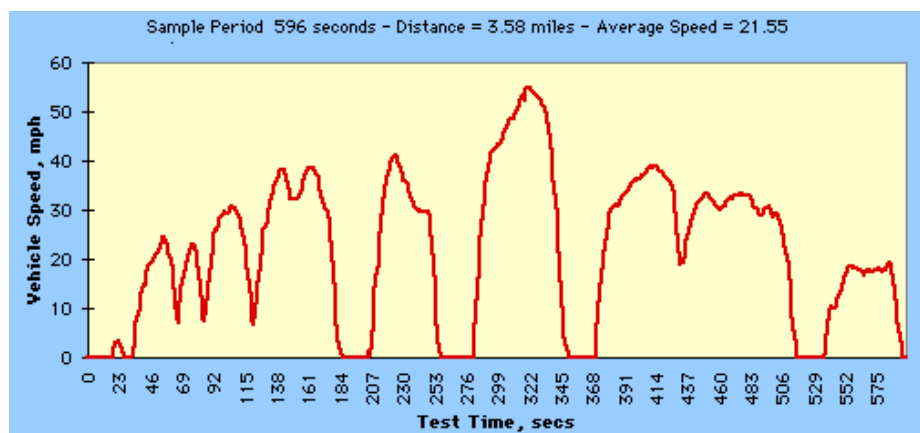


Figure 5. SC03 Test Cycle Speed Trace

b. Test Procedures at NVFEL

The procedures for each FTP, HWFE, US06, SC03 test are listed below. Asterisks indicate results ERG used for evaluating how each calibration affected engine operation in Section IV.B and emissions in Section IV.C. EPA used the same dynamometer calibration settings for each test which are provided in Section III.C. For each calibration tested on the FTP, EPA completed the following procedure. Asterisks (*) mark specific test runs that result in emissions test results for the purpose of evaluating the tuners.

1. Performed one prep (FTP-72) test cycle (engine could be cold, warm, or hot).
2. Allowed a 12 to 36 hour soak period.
3. Performed the FTP75 test cycle:
 - a. Performed Phase 1 of the FTP test cycle (cold start).*
 - b. Performed Phase 2 of the FTP test cycle (stabilization phase).*
 - c. Allowed a 10 minute engine off period.
 - d. Performed Phase 3 of the FTP test cycle (hot start).*

ERG used the weighted bag results¹⁴ for all three phases of the FTP75 test cycle as the valid result for comparing results in Section IV.C. This ensures that the vehicle's engine and emission control devices were at the same operating temperature at the beginning of each second and valid test cycle.

HWFE Tests

For each calibration tested on the HWFE, EPA completed the following procedure:

1. Performed one HWFE test cycle.
2. Performed a second consecutive HWFE test cycle immediately after Step 1. This inherently included a short engine-on idle period following Step 1, as specified in the HWFE speed trace at the end and beginning of each HWFE test cycle.*

ERG only used the result from this second consecutive HWFE cycle (Step 2 above) for evaluating how each calibration affected emissions in Section IV. This ensures that the vehicle's engine and emission control devices were at the same operating temperature at the beginning of each second and valid test cycle.

US06 Tests

For each calibration tested on the US06, EPA completed the following procedure:

1. Performed one US06 test cycle.
2. Performed a second consecutive US06 test cycle immediately after Step 1. This inherently included a short engine-on idle period following Step 1, as specified in the US06 speed trace at the end and beginning of each US06 test cycle.*

ERG only used the result from this second consecutive US06 cycle (Step 2 above) for evaluating how each calibration affected emissions in Section IV. This ensures that the vehicle's engine and emission control devices were at the same operating temperature at the beginning of each second and valid test cycle.

SC03 Tests

For each calibration tested on the SC03, EPA completed the following procedure:

1. Performed one SC03 test cycle.
2. Allowed a 10 minute engine off period.
3. Performed a second consecutive SC03 test cycle.*

ERG only used the result from this second consecutive SC03 cycle (Step 2 above) for evaluating how each calibration affected emissions in Section IV. This ensures that the vehicle's engine and emission control devices were at the same operating temperature at the beginning of each second and valid test cycle.

C. Quality Assurance and Other Documentation

The EPA NVFEL followed the quality assurance and dynamometers testing procedures outlined in a quality assurance project plan (QAPP) titled *OECA Test Program at NVFEL: Aftermarket Tuning Effect on Emissions - QAPP (October 2015)*. The QAPP incorporates by reference the procedures set forth in

¹⁴ The weighted bag results are calculated by the EPA NVFEL and reported on the official report.

the EPA NVFEL's *QSP-514 Vehicle Testing Practices, Version 7, (04/28/2015)*. The EPA NVFEL is accredited in accordance with the recognized International Standard ISO/IEC 17025:2005.¹⁵

ERG performed additional quality control checks after receiving all results from the EPA NVFEL. These checks are summarized in Table 8 and Table 9 for the F-250 and F-150, respectively. Each test can be identified in the raw emissions results files contained in Appendix D using the test identifier assigned by the EPA NVFEL. ERG verified that the same inertia weight and set coefficients were used for each test.

Table 8. 2012 MY F-250 Test Documentation

Test and Vehicle Calibration		EPA NVFEL Test ID ^a	Test Date	Beginning Odometer (mi.)	Dynamometer Calibration Settings ^b				Soak Period (hr.) ^c
					Inertia (lbs.)	EPA Set Co A	EPA Set Co B	EPA Set Co C	
FTP	Baseline	2016-0026-006	10/28/2015	52,832	9,500	-16.94	-0.5339	0.0496	20.8
HWFE	Baseline	2016-0026-003	10/28/2015	52,843	9,500	-16.94	-0.5339	0.0496	N/A
US06	Baseline	2016-0026-004	10/28/2015	52,863	9,500	-16.94	-0.5339	0.0496	N/A
SC03	Baseline	2016-0026-005	10/28/2015	52,879	9,500	-16.94	-0.5339	0.0496	N/A
FTP	BD-VOID	2016-0026-008	10/29/2015	52,895	9,500	-16.94	-0.5339	0.0496	14
HWFE	BD-VOID	2016-0026-009	10/29/2015	52,906	9,500	-16.94	-0.5339	0.0496	N/A
US06	BD-VOID	2016-0026-010	10/29/2015	52,926	9,500	-16.94	-0.5339	0.0496	N/A
SC03	BD-VOID	2016-0026-011	10/29/2015	52,940	9,500	-16.94	-0.5339	0.0496	N/A
FTP	BD-Valid	2016-0026-016	11/10/2015	52,973	9,500	-16.94	-0.5339	0.0496	17.9
HWFE	BD-Valid	2016-0026-018	11/10/2015	52,984	9,500	-16.94	-0.5339	0.0496	N/A
US06	BD-Valid	2016-0026-019	11/10/2015	53,004	9,500	-16.94	-0.5339	0.0496	N/A
SC03	BD-Valid	2016-0026-020	11/10/2015	53,019	9,500	-16.94	-0.5339	0.0496	N/A

a – This is the test identifier associated with the raw emissions reports assigned by the EPA NVFEL.

b – These is dynamometer calibration settings from the raw emissions reports in Appendix D.

c – This is the length of the cold soak period. It starts when the engine was turned off at the end of the prep cycle and ends when the engine is started for the FTP test.

Table 9. 2013 MY F-150 Test Documentation

Test and Vehicle Calibration		EPA NVFEL Test ID ^a	Test Date	Beginning Odometer (mi.)	Dynamometer Calibration Settings ^b				Soak Period (hr.) ^c
					Inertia (lbs.)	EPA Set Co A	EPA Set Co B	EPA Set Co C	
FTP	Baseline	2016-0030-002	11/3/2015	47,036	6,000	-12.59	-0.0583	0.03829	16.5
HWFE	Baseline	2016-0030-003	11/3/2015	47,047	6,000	-12.59	-0.0583	0.03829	N/A
US06	Baseline	2016-0030-004	11/3/2015	47,068	6,000	-12.59	-0.0583	0.03829	N/A
SC03	Baseline	2016-0030-005	11/3/2015	47,084	6,000	-12.59	-0.0583	0.03829	N/A
FTP	SCT 7015	2016-0030-006	11/6/2015	47,107	6,000	-12.59	-0.0583	0.03829	16.0
HWFE	SCT 7015	2016-0030-007	11/6/2015	47,119	6,000	-12.59	-0.0583	0.03829	N/A
US06	SCT 7015	2016-0030-008	11/6/2015	47,140	6,000	-12.59	-0.0583	0.03829	N/A
SC03	SCT 7015	2016-0030-009	11/6/2015	47,156	6,000	-12.59	-0.0583	0.03829	N/A
FTP	Baseline	2016-0030-002	11/3/2015	47,036	6,000	-12.59	-0.0583	0.03829	16.5
HWFE	Baseline	2016-0030-003	11/3/2015	47,047	6,000	-12.59	-0.0583	0.03829	N/A

¹⁵ The EPA's NVFEL accreditation was valid from 7 April 2015 through 30 April 2016. See <http://www3.epa.gov/nvfel/documents/cert-epa-nvfel-isoiec-17025-scope-2015-04.pdf>

Table 9. 2013 MY F-150 Test Documentation

Test and Vehicle Calibration		EPA NVFEL Test ID ^a	Test Date	Beginning Odometer (mi.)	Dynamometer Calibration Settings ^b				Soak Period (hr.) ^c
					Inertia (lbs.)	EPA Set Co A	EPA Set Co B	EPA Set Co C	
US06	Baseline	2016-0030-004	11/3/2015	47,068	6,000	-12.59	-0.0583	0.03829	N/A

a – This is the test identifier associated with the raw emissions reports assigned by EPA NVFEL.

b – This is dynamometer calibration information from the raw emissions reports in Appendix D.

c – This is the length of the cold soak period. It starts when the engine was turned off at the end of the prep cycle and ends when the engine is started for the FTP test.

As part of EPA's NVFEL standard operating procedure, derivation tests are run with each vehicle on the dynamometer in order to determine the correct set coefficients. This process calibrates the dynamometer to request the proper road load from the vehicle being tested. In order to run the derivation tests, values known as "manufacturer target coefficients" must be used as inputs which were reported to the EPA NVFEL by Ford prior to testing and are shown in Table 10 below along with the resulting set coefficients (also shown in Table 8 and Table 9 above).

Table 10. Manufacture Target Coefficients and EPA Set Coefficients

Parameter		Test Vehicle	
		F-250	F-150
Manufacturer Target Coefficients Reported by Ford to the EPA NVFEL	Target A	64.98	63.52
	Target B	1.5436	0.5449
	Target C	0.03721	0.03725
Manufacturer Target Coefficients Used by the EPA NVFEL	Target A	64.98	63.52
	Target B	1.3544 ^a	0.5449
	Target C	0.03721	0.03725
EPA Set Coefficients determined by the EPA NVFEL via Derivation Runs	Set Coefficient A	-16.94	-12.59
	Set Coefficient B	-0.5339	-0.0583
	Set Coefficient C	0.0496	0.03829

a – This coefficient was incorrectly entered by the EPA NVFEL before the derivation run for the F-250. The EPA NVFEL determined that this error resulted in 2.30 to 4.24 percent less road load demanded by the dynamometer from the F-250, depending on the speed, compared to if the correct coefficient was used.

It is important to note that for the F-250 test, the manufacture target coefficient was incorrectly entered for the derivation run on 26 October 2015 as 1.3544; the correct value was 1.5436. As a result, the set coefficient B determined by the EPA NVFEL for the F-250 was also incorrect. However, for the purpose of this testing, EPA used the same EPA set coefficients for all remaining tests because the error was not identified until after the first valid Bully Dog test was completed for the F-250. Further, the EPA NVFEL determined this error resulted in 2.30 to 4.24 percent less road load demanded by the dynamometer from the F-250, depending on the speed, compared to if the correct coefficient had been used. Because less road load does not adversely affect (increase) emissions, the EPA MSEB and ERG decided the selected coefficients used were sufficiently suitable for the purpose of this testing. Appendix E provides the documentation the EPA MSEB and ERG received from the EPA NVFEL regarding the difference in road load.

IV. EMISSIONS TESTING RESULTS

The following subsections summarize the results and observations from the emissions testing at the EPA NVFEL including OBD data observations, analysis of live engine data, and measured emissions.

- Section IV.A summarizes observations of general diagnostic information reported through the OBD before and after tuner installation.
- Section IV.B summarizes ERG's analysis of live engine data obtained during the testing.
- Section IV.C summarizes the measured emissions results.

A. OBD Scan Tool Data Observations

As described in Section III.B.2, before and after installation of each tuner calibration, ERG immediately removed the tuner, connected an OBD II scan tool to the OBD II DLC on the test vehicle, and obtained OBD data. ERG observed DTCs, the status of the MIL, Cal ID¹⁶, and CVN.¹⁷ It is important to note that when a tuner is unplugged, the most recent calibration remains installed on the ECM, along with any software modifications.

1. F-250 – 6.7 Liter Ford Powerstroke

Table 11 shows OBD data observed on the F-250 test vehicle at various stages of testing. Ford verbally confirmed the week of 26 October 2015 that the F-250 test vehicle contained the most recent production calibration¹⁸. The observed CVN 1 changed from the stock CVN 1 value after installing the Bully Dog 40420 tuner calibration confirming that the tuner modified the stock calibration in some way. The tuner also altered the Cal ID 1 name when installing the modified calibration. CVN 2, CVN 3, and CVN 4¹⁹ never changed during the course of testing. After installing the Bully Dog 40420 tuner calibration and starting the engine, the OBD II scan tool always reported the MIL as “off” and no DTCs were present.

As shown in Table 11, the observed Cal ID 1 and CVN 1 did not match the stock value as received from Ford after returning the F-250 calibration to stock following the first and void Bully Dog test on 28 October 2015. However, when the Bully Dog 40420 tuner was reinstalled on 2 November 2015 before the valid Bully Dog test, the observed Cal ID 1 and CVN 1 values matched the observed values from the initial installation of the Bully Dog tune on 28 October 2015. This confirms that the same Bully Dog calibration was installed for both the void and valid Bully Dog test.

¹⁶ The Cal ID represents the software version, which includes the engine data maps.

¹⁷ The CVN is the result of a 'check-sum' calculation performed by the OBD system using the engine data maps as inputs. If the data values have not been changed or corrupted, the CVN will always provide the same sum for a given Cal ID. If the ECM has been modified or corrupted, the CVN calculation will generate an incorrect 'sum'.

¹⁸ A “production” calibration is one that can be found on vehicles sold to consumers at Ford dealerships. This excludes calibrations that OEMs may use during research and development.

¹⁹ There are multiple Cal ID because there are multiple control modules for this engine.

Table 11. OBD Scan Tool Observations During Emissions Testing on MY 2012 F-250 with a 6.7 Liter Powerstroke Diesel Engine

Parameter	Stock ^a	BD Tune (void test) ^b	Returned to Stock ^c	BD Tune (valid test) ^d
	10/28/2015	10/28/2015	10/29/2015	11/2/2015 and 11/6/2015
TCM Cal ID	Not Reported	Not Reported	Not Reported	Not Reported
TCM CVN	1426FABE	1426FABE	1426FABE	1426FABE
Cal ID 1	DDCM2A6.H32	DDBN3C3.H32	DDCL0CA.H32	DDBN3C3.H32
Cal ID 2	BC3A-14D609-BA	BC3A-14D609-BA	BC3A-14D609-BA	BC3A-14D609-BA
Cal ID 3	Not Reported ^e	Not Reported ^e	DC3A-14F553-AA	DC3A-14F553-AA
Cal ID 4	Not Reported ^e	Not Reported ^e	DC3A-14G265-AC	DC3A-14G265-AC
CVN 1	20AADB09	9F71DCDC	6A188191	9F71DCDC
CVN 2	0885FD1F	0885FD1F	0885FD1F	0885FD1F
CVN 3	000009AE	000009AE	000009AE	000009AE
CVN 4	0000CD85	0000CD85	0000CD85	0000CD85
MIL Status	Off	Off	Off	Off
Inactive DTCs	0	0	0	0
Active DTCs	0	0	0	0

a – OBD data observed prior to any testing.

b – OBD data observed after installing Bully Dog calibration prior to void test in which DPF regeneration occurred.

c – OBD data observed after returning ECM to stock after the void test in which DPF regeneration occurred.

d – OBD data observed after reinstalling Bully Dog calibration prior to the final and valid test in which DPF regeneration did not occur. This matched the original calibration based on observed Cal IDs and CVNs. ERG checked these values on 2 November 2015 and also on 6 November 2015. The EPA NVFEL performed the valid test on 10 November 2015.

e – The OBD scan tool used prior to 28 October 2015 was an AutoXray® 4000, which did not report Cal ID 3 and 4 but did report CVN 3 and 4. Starting on 29 October 2015, ERG used a Nexiq Pocket IQ scan tool and was able to observe Cal ID 3 and 4.

1. F-150 – 3.5 Liter Ford EcoBoost

Table 12 shows OBD data observed on the F-150 test vehicle at various stages of testing. Ford verbally confirmed the week of 2 November 2015 that the F-150 test vehicle contained the most recent production calibration. The observed CVN changed from the stock CVN after installing the SCT 7015 tuner calibration, confirming that the tuner modified the stock calibration maps in some way. The tuner did not alter the Cal ID name when installing a modified calibration. After installing the SCT 7015 tuner calibration and starting the engine, the OBD II scan tool reported the MIL as “off” and no DTCs were present. Additionally, the observed Cal ID and CVN matched the original values after returning the ECM to stock, verifying that the SCT 7015 tuner successfully returns the ECM to its stock calibration with no trace of modification using a generic OBD scan tool.

Table 12. OBD Scan Tool Observations During Emissions Testing on MY 2013 F-150 with a 3.5 Liter EcoBoost Gasoline Engine

Parameter	Stock ^a	SCT 7015 Tune ^b	Returned to Stock
	11/2/2015	11/3/2015	11/6/2015
Cal ID	KGCTAA6.H32	KGCTAA6.H32	KGCTAA6.H32
CVN	7BDE06C5	E579F642	7BDE06C5
MIL Status	Off	Off	Off
Inactive DTCs	0	0	0
Active DTCs	0	0	0

a – OBD data observed prior to any testing.

b – OBD data observed after installing the Performance SCT 7015 calibration.

c – OBD data observed after returning ECM to stock after the SCT 715 test.

B. Live Engine Data

During the testing, the EPA and ERG logged live engine operating data by connecting a data logger directly to the OBD II data link connector. ERG logged data during both baseline tests and tuner tests performed on the dynamometer and also on-road tests to identify possible changes in engine and emission control system operation. After testing, ERG analyzed the live data, focusing on parameters that might affect emissions performance if altered from the designed operating range. The data logger models used and general analysis methods are provided in Section III.B.3. The Microsoft Excel analysis files are provided in Appendix F and G and include ERG's analysis and raw data. The following two subsections summarize the results for the F-250 test vehicle with the Bully Dog 40420 tuner installed and the F-150 test vehicle with the SCT 7015 tuner installed.

1. F-250 – 6.7 Liter Ford Powerstroke

ERG observed several changes to engine and emission control device operation on the F-250 test vehicle with the Bully Dog 40420 tuner installed compared to the baseline tests with the stock calibration installed. The parameters for which ERG identified changes are listed below and are discussed in the following subsections. Relevant figures and data tables are provided in these subsections, and Appendix F contains ERG's entire data analysis for the F-250 tests including more detailed descriptions of the data parameters.

- Inferred DPF loading
- Commanded EGR
- SCR ammonia level
- Manifold absolute pressure
- Engine load
- Fuel injection timing

ERG also examined all other logged parameters for which no significant changes were identified with the Bully Dog 40420 tuner installed, including variable geometry turbo charger, fueling injection quantity, engine reference torque, and SCR adaptation factor. A complete list of parameters acquired is provided in Appendix F.

The live data was also used to monitor the status of DPF regeneration. Specifically, ERG reviewed the “Diesel Particulate Filter Regeneration Status” parameter²⁰ for each test to ensure that a DPF regeneration did not occur. This parameter is set to a value of zero if no regeneration is occurring or a value of one if a regeneration is occurring. As explained in Section III.B, ERG determined that a DPF regeneration did occur during the first Bully Dog 40420 tuner test on 29 October 2015²¹. As a result, all live data and emission tests results from that test were considered void by the EPA MSEB and ERG. The EPA NVFEL performed a second Bully Dog 40420 tuner test on the F-250 test vehicle on 10 November 2015 during which ERG confirmed no DPF regeneration occurred.

a. Inferred DPF Loading

The inferred DPF loading²² parameter is the soot loading on the DPF represented as a percentage of the maximum possible soot loading (0 = clean, 100 = dirty). The EPA MSEB and ERG were unable to obtain information from SAE documents or Ford representatives about how the ECM calculates this parameter and uses it to monitor or control the DPF. However, EPA did identify useful information from certification documents for the MY 2012 6.7 liter Powerstroke engine family (CFMXXD06.761A) which state that [REDACTED]

[REDACTED] DPF regenerations are high emission events and the frequency at which they occur must be accounted for during the engine certification process (see Section III.A).

As shown in Table 13, over the course of all tests (FTP, HWFE, US06, and SC03), the cumulative change (i.e., delta) of inferred DPF loading increased at a higher rate with the Bully Dog 40420 tuner installed compared to the stock calibration.²³ Observations varied by test. On the FTP test, it increased nearly twice as much with the tuner installed (see Figure 6). For both the HWFE and US06 tests, the inferred DPF loading slightly increased with the Bully Dog 40420 tuner installed from the beginning of the test to the end. On the other hand, the inferred DPF loading decreased (i.e., soot was burned off) with the stock calibration over these two tests (see Figure 7). For the US06 and HWFE tests, it’s plausible for the DPF loading to decrease (i.e., burn off soot), not increase (i.e., accumulate soot), as a result of higher engine load and temperatures over those tests, which might passively burn off soot. This is demonstrated by the baseline tests but not the Bully Dog tests.

DPF loading increases were greater on the baseline SC03 test than the Bully Dog SC03 test. However, the fuel economy increased by 11 percent during the Bully Dog SC03 test and the absolute load recorded with the data logger was reduced, indicating the A/C was turned off during the Bully Dog SC03 test. ERG was not present during this test on 10 November 2015 to confirm this condition (i.e., A/C turned off) but was present for the baseline test on 28 October 2015 when it was turned on per the SC03 test procedure.

ERG conducted internet searches related to the Bully Dog 40420 tuner and identified several customers who have complained about DPF regeneration frequency when using the Bully Dog 40420 tuner. Appendix H provides screenshots of all examples identified. Below are examples contained in Appendix H.

I have been using a bullydog triple dog set to extreme. The EGR and DPF clogged up pretty good and the mechanic i took it to said that could be the cause...The extreme setting runs more fuel thru the system the the emissions system has time to clean up[sic].

²⁰ Ford parameter ID FPID-F48B

²¹ Active DPF regeneration began in phase 3 (of 3) of the FTP test and finished during the HWFE warm up test cycle. However, the effects on emissions and engine operation before and after regeneration occurred are unknown.

²² Ford enhanced parameter FPID-042C

²³ It is possible that the modifications made to other parameters by the Bully Dog 40420 tuner affected the accuracy of the DPF loading calculation.

This dealer said it was "plugged exhaust filter due to aftermarket tuner.

Dont use the tuner with the DPF still intact. This is why your DPF keeps getting plugged up...Best thing you can do is DOC, DPF delete, EGR turned off/unplugged/EGR blocker plate [sic].

Bully Dog has no tune for the LML yet. Waste of time using a tuner without doing full deletes anyway. Your mileage will drop if anything useing a tuner with DPF intact due to the more frequent regen needed from added fuel of the tuner[sic]..

Before the tuner I was about 1 regen per tank. Now I am experiencing a regen about every 100-125 miles (about 4-5 times per tank)... I do like the power gain. Just not to impressed with the constant regeneration cycles. I just hope it doesn't have any long term effects on the truck. The way i'm thinking about it is like this: At 100,000 miles with the tuner, the truck will have regenerated as many times as it would at 400,0000 miles without the tuner (before I was regenerating 1 time per tank on average)[sic].

Table 13. Inferred DPF Loading (Percent) for F-250 Testing with the Bully Dog 40420 Tuner

Test	Baseline Test (i.e., Stock)			Bully Dog Test (Extreme setting)		
	Test Start Value ^a	Test End Value ^a	Delta ^b	Test Start Value ^a	Test End Value ^a	Delta ^b
FTP	83.3	87.2	4.0	15.3	23.3	8.0
HWFE	85.5	83.3	-2.3	22.7	23.3	0.6
US06	76.5	71.4	-5.1	28.4	29.5	1.1
SC03	78.2	83.3	5.1	32.2	32.9	0.6
Total ^c	83.3	83.3	0	15.3	32.9	17.6

Blue – Fuel economy increased by 11 percent and reduced absolute load recorded with the data logger indicates the A/C was turned off during the Bully Dog SC03 test. ERG was not present during this test on 10 November 2015 to confirm but was present for the baseline test on 28 October 2015 when it was turned on per the SC03 test procedure.

a – The inferred DPF loading at the end of each individual test does not match the DPF loading at the beginning of the subsequent test because, as explained in Section III.B.4, each test included two consecutive test cycles but only the second test cycle is used to generate official test results.

b – A positive delta indicates the soot loading on the DPF increased over the test. A negative value indicates the soot loading on the DPF decreased over the test.

c – This is the total change in inferred DPF loading from the start of the FTP test to the end of the SC03 test.

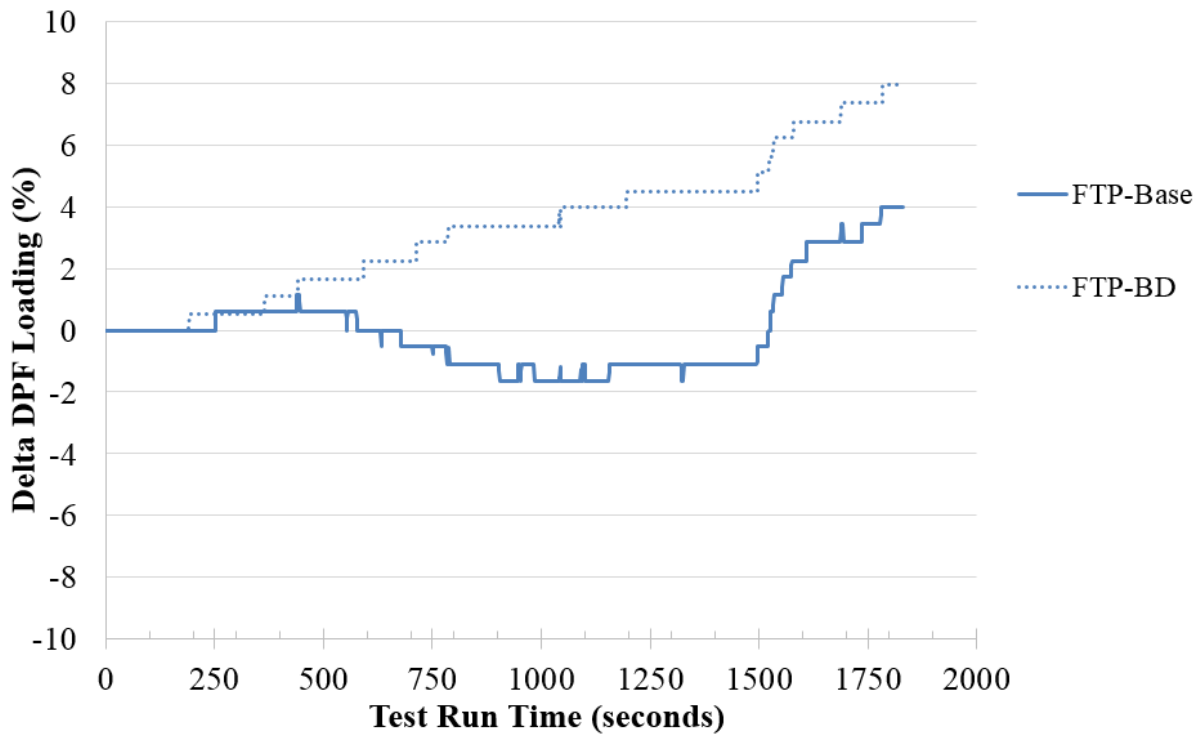


Figure 6. Inferred Delta DPF Loading (%) on the FTP Test

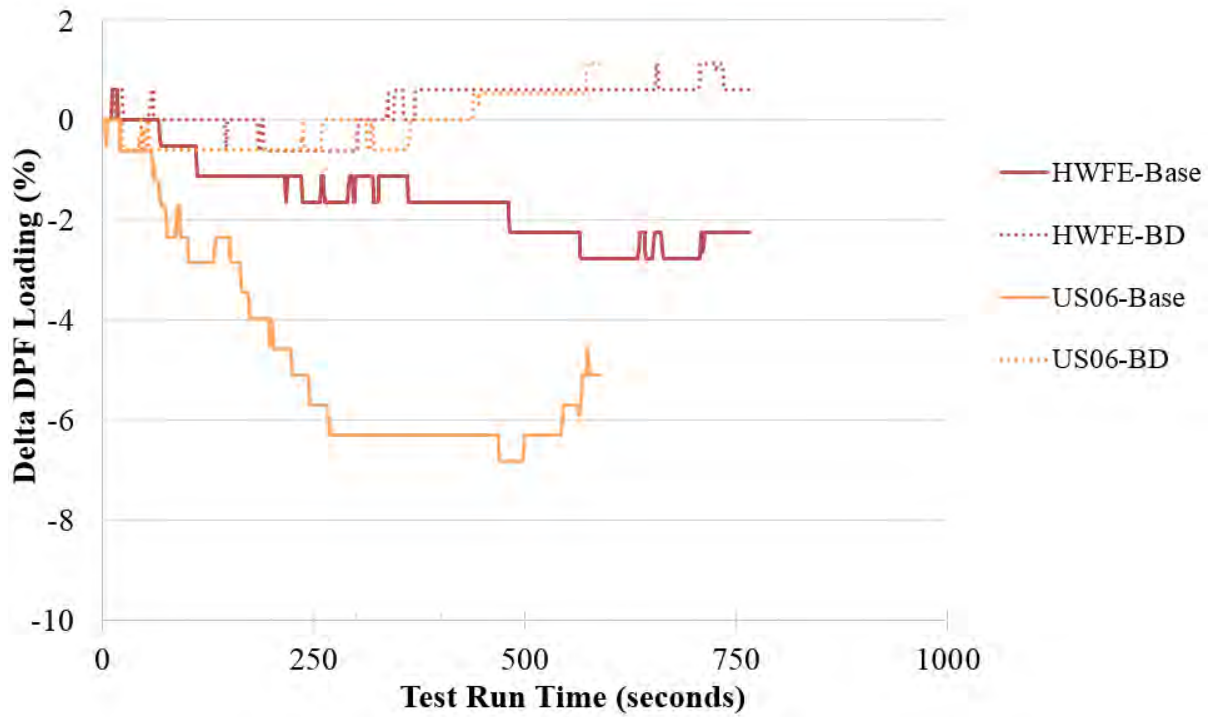


Figure 7. Inferred Delta DPF Loading (%) on the HWFE and US06 Tests

a. Commanded EGR

The EGR parameter is the commanded EGR duty cycle or position²⁴ which is directly related to the actual flow of recirculated exhaust gases through the EGR system (0 = valve closed/no flow, 100 = valve open/full flow). The live data showed that Bully Dog Extreme tuner did not disable the EGR system. Instead, there was an increase in the usage of EGR observed on all tests as shown in Figure 8. It is unknown if the tuner directly alters EGR operation or if the ECM responded to changes of other parameters made by the tuner by increasing the use of EGR. According to a document titled *6.7L Powerstroke Diesel Engine: Engine Description, Systems Overview, and Component Location*,²⁵ the commanded EGR is determined by intake pressure, engine load, engine temperature, exhaust pressure, and engine speed (RPM). See Sections IV.B.1.c and IV.B.1.d, respectively, for changes observed to intake pressure and calculated engine load.

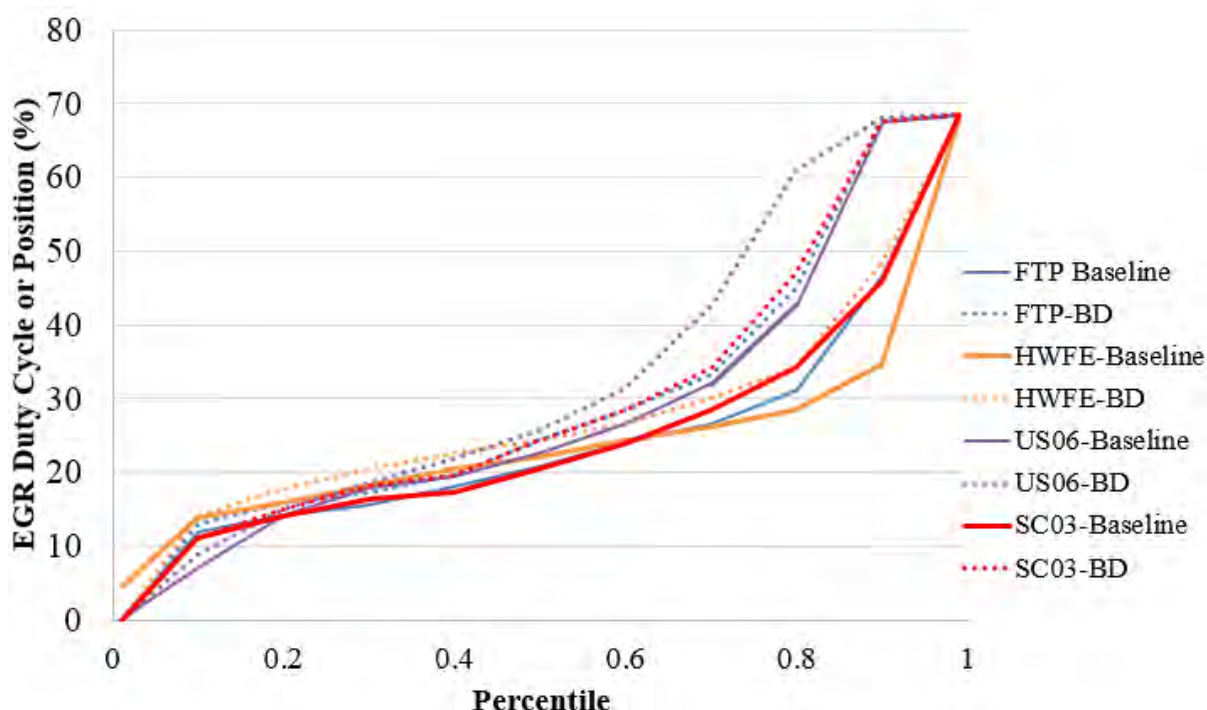


Figure 8. Actual EGR A Duty Cycle or Position (%) Data Logged from the F-250 Test Vehicle

b. SCR Ammonia Level

The live data show the Bully Dog Extreme tuner did not disable the SCR system. However, as shown in Figure 9, there was a decrease in the inferred SCR ammonia level²⁶ for all tests with the Bully Dog 40420 tuner installed with the exception of the SC03 test. However, as previously explained, fuel economy increased by 11 percent and reduced absolute load recorded with the data logger indicates the A/C was turned off during the Bully Dog SC03 test. ERG was not present during the Bully Dog SC03 test on 10

²⁴ Ford enhanced parameter FPID-469

²⁵ Available online at: http://www.ford-trucks.com/ford-manuals/6.7L_Diesel.pdf.

²⁶ This is Ford enhanced parameter FPID-047C. The EPA MSEB and ERG were unable to obtain information from Ford about the SCR ammonia (i.e., urea) level such as what the value represents, how the ECM calculates the value, and if the ECM uses it to monitor or control the SCR system.

November 2015 to confirm but was present for the baseline test on 28 October 2015 when it was turned on. Therefore, it is unknown if the lack of A/C operation on the Bully Dog SC03 test affected the inferred SCR ammonia level. It is also unknown if the accuracy of this inferred value is affected by other changes made by the tuner, if a possible increase in engine out NO_x emissions caused by the tuner depleted the SCR ammonia level, or if the tuner directly alters SCR operation by decreasing the ammonia dosing rate.

ERG also evaluated ammonia dosing rates collected by the data logger²⁷; however, it was determined that the rates are calculated averages over a 48 hour period of engine operation or the period needed for a demanded reagent consumption of at least 15 liters, whichever is longer. Since each test was much shorter than these periods, the data was not useful for comparing dosing rates with the stock calibration (i.e., baseline) to dosing rates with the Bully Dog 40420 tuner installed.

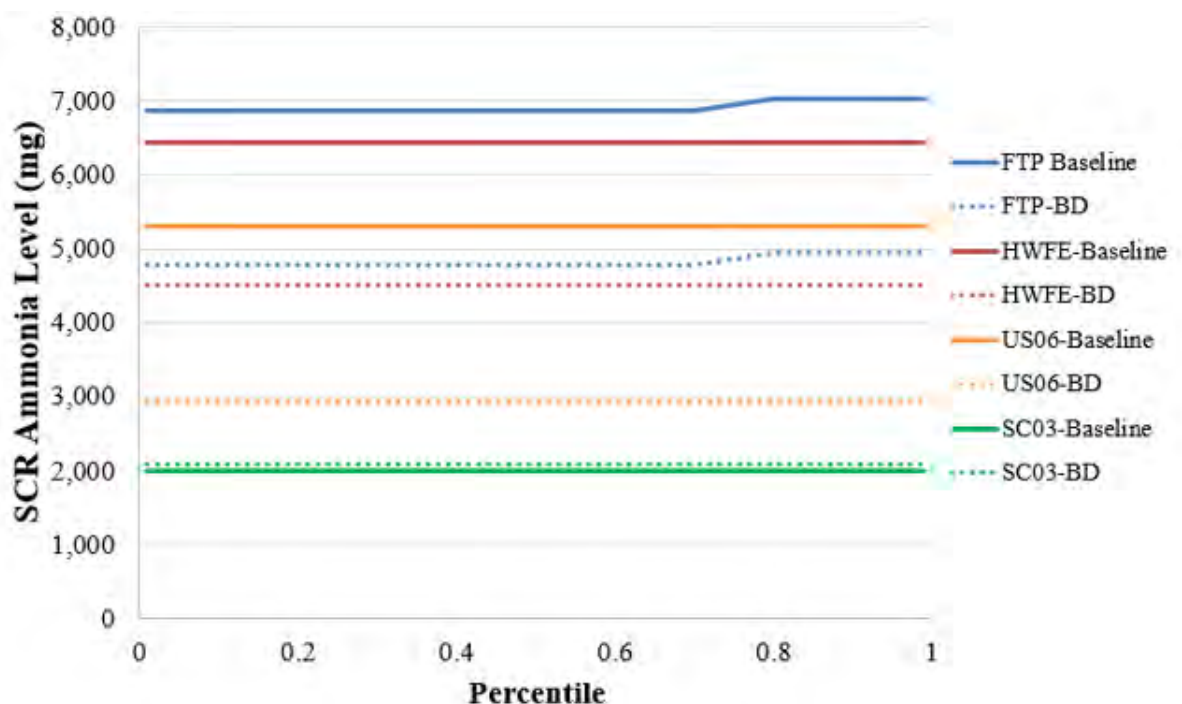


Figure 9. Inferred SCR Ammonia Level Data Logged from the F-250 Test Vehicle²⁸

c. Manifold Absolute Pressure

The manifold absolute pressure (MAP) parameter²⁹ is the absolute pressure, in kilopascals (kPa), measured directly by a sensor in the intake manifold. As shown in Figure 10, the data indicate that there is an increase in MAP with the Bully Dog 40420 tuner installed on the FTP, US06, and SC03 tests but not on the HWFE test. According to a document titled *6.7L Powerstroke Diesel Engine: Engine Description, Systems Overview, and Component Location*,³⁰ the measured MAP is monitored by the ECM to control turbocharger, EGR, and DPF regeneration. Based on this information, a change in MAP may affect overall engine and/or emission control performance.

²⁷ Ford enhanced parameter FPID-F485

²⁸ Fuel economy increased by 11 percent and reduced absolute load recorded with the data logger indicates the A/C was turned off during the Bully Dog SC03 test. ERG was not present during this test on 10 November 2015 to confirm but was present for the baseline test on 28 October 2015 when it was turned on per the SC03 test procedure.

²⁹ Ford enhanced parameter FPID-F487.

³⁰ Available online at: http://www.ford-trucks.com/ford-manuals/6.7L_Diesel.pdf.

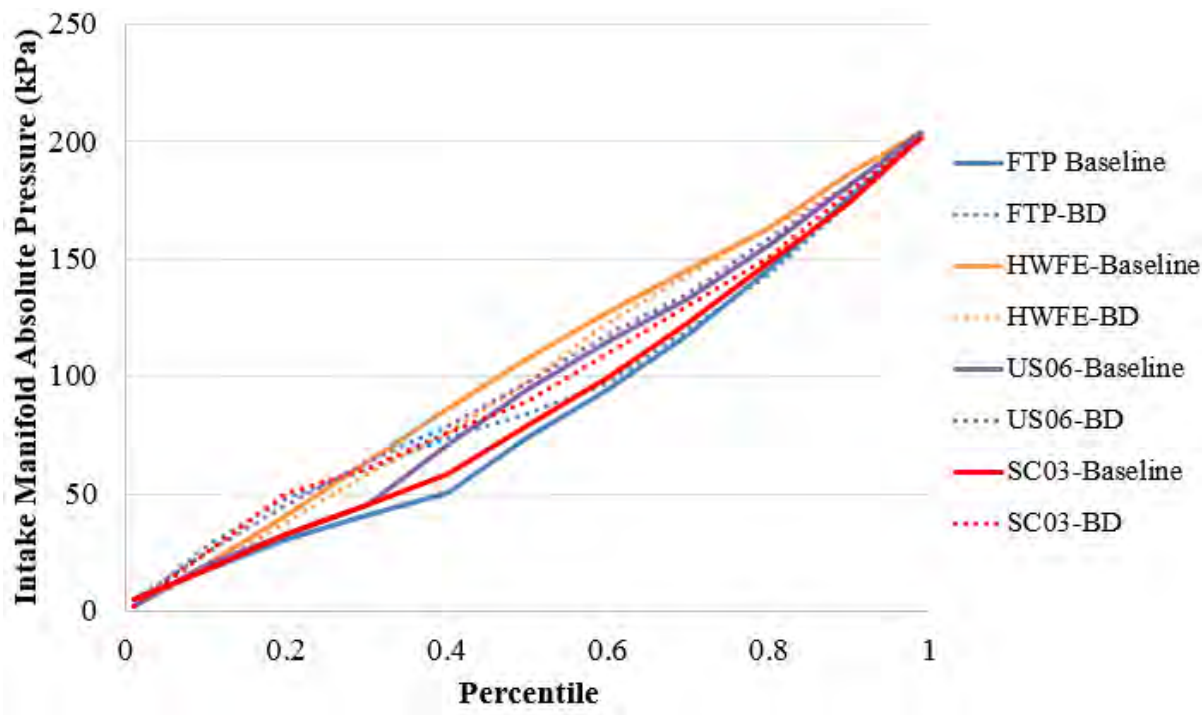


Figure 10. Manifold Absolute Pressure (kPa) Data Logged from the F-250 Test Vehicle³¹

d. Engine Load

The engine load³² parameter represents the instantaneous engine load as a percentage of total possible engine load as a function of RPM. According to SAE J1979, its calculation is proportional to the instantaneous air flow divided by the maximum air flow at wide open throttle as a function of engine RPM. However, it is unknown if this methodology is in fact used for this test vehicle since other methods may be used. As shown in Figure 11, the data show that there was a significant decrease in engine load with the Bully Dog 40420 tuner installed on all tests. According to a document titled *6.7L Powerstroke Diesel Engine: Engine Description, Systems Overview, and Component Location*,³³ the engine load on this test vehicle is used to control other systems important for emission control including the EGR, turbo charger, and fuel injection pressure. Based on this information, a change in engine load may affect overall engine and/or emission control performance.

³¹ Fuel economy increased by 11 percent and reduced absolute load recorded with the data logger indicates the A/C was turned off during the Bully Dog SC03 test. ERG was not present during this test on 10 November 2015 to confirm but was present for the baseline test on 28 October 2015 when it was turned on per the SC03 test procedure.

³² Ford enhanced parameter FPID-F404. ERG believes this is similar to SAE J1979 PID\$04.

³³ Available online at: http://www.ford-trucks.com/ford-manuals/6.7L_Diesel.pdf.

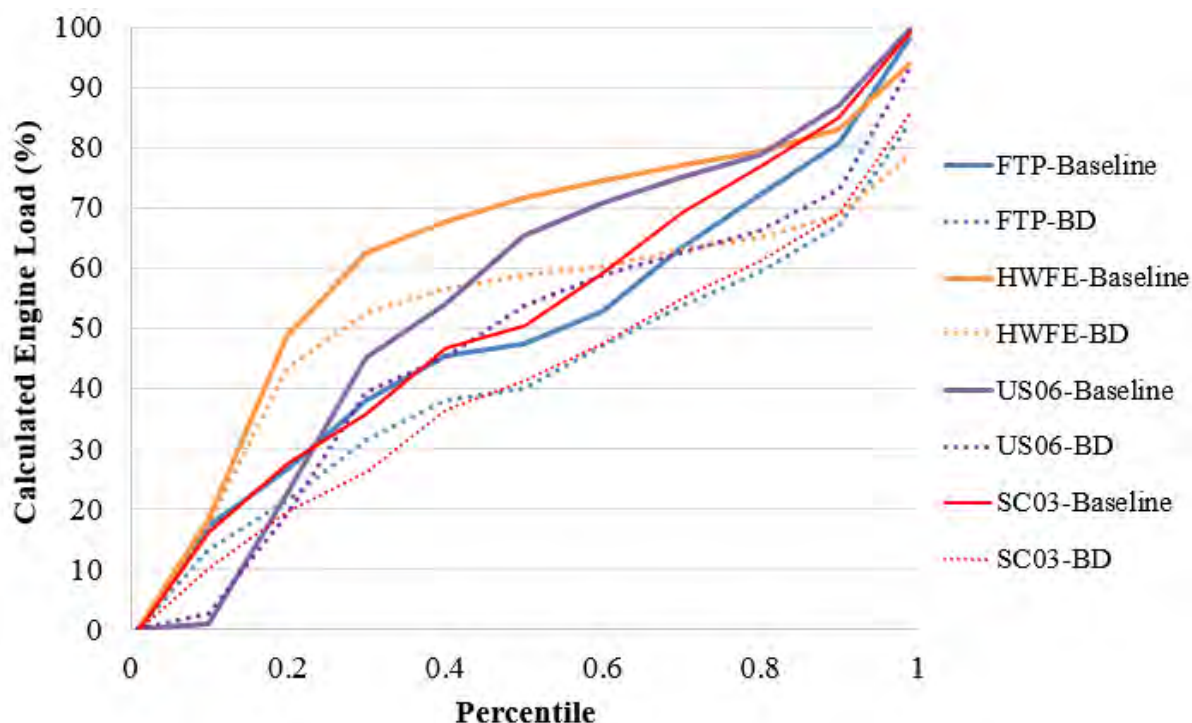


Figure 11. Engine Load (percent) Data Logged from the F-250 Test Vehicle³⁴

e. Fuel Injection Timing

The fuel injection timing parameter³⁵ represents the point in which main fuel injection begins in degrees before (positive number) or after (negative number) top dead center. As shown in Figure 12, the data shows a small timing advance with the Bully Dog 40420 tuner installed on some of the test cycles. On the HWFE test, advancements in fuel injection timing were most apparent for a small portion of the test shown in the zero to 20th percentile range in Figure 12. Changes in fuel injection timing may have a direct impact on engine out NO_x emissions. However, The EPA and ERG were unable to log data related to fuel injection duration, which may also have an effect on emissions.

³⁴ Fuel economy increased by 11 percent and reduced absolute load recorded with the data logger indicates the A/C was turned off during the Bully Dog SC03 test. ERG was not present during this test on 10 November 2015 to confirm but was present for the baseline test on 28 October 2015 when it was turned on per the SC03 test procedure.

³⁵ Ford enhanced parameter FPID-F45D.

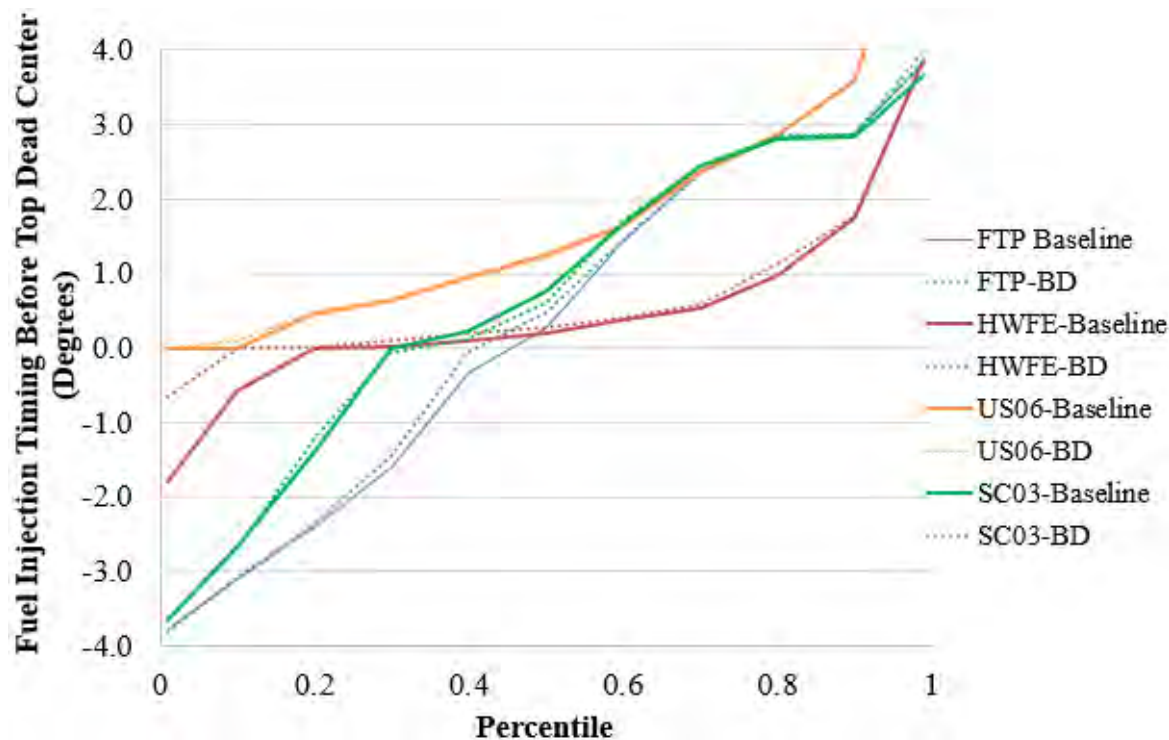


Figure 12. Fuel Injection Timing Data Logged from the F-250 Test Vehicle³⁶

1. F-150 – 3.5 Liter Ford EcoBoost

ERG observed several changes to engine operation on the F-150 test vehicle with the SCT 7015 tuner installed compared to the baseline tests with the stock calibration installed. The parameters for which ERG identified changes are listed below and are discussed in the following subsections. Relevant figures and data tables are provided in these subsections, and Appendix G contains ERG's entire data analysis for the F-150 tests including more detailed descriptions of the data parameters.

- Engine load
- Long-term fuel trims

ERG also examined all other logged parameters for which no significant changes were identified with the SCT 7015 tuner installed, including manifold absolute pressure, catalyst temperature, commanded throttle actuator, commanded air-to-fuel ratio, fuel rail pressure, ignition timing advance, and short-term fuel trim.

a. Engine Load

The engine load parameter³⁷ represents the instantaneous engine load as a percentage of total possible engine load as a function of RPM. According SAE J1979, its calculation is proportional to the instantaneous air flow divided by the maximum air flow at wide open throttle as a function of engine RPM. However, it is unknown if this methodology is in fact used for this test vehicle since other methods may be used. As shown in Figure 13, the data show that there was a significant decrease in engine load with the SCT 7015 tuner installed on all tests.

³⁶ Fuel economy increased by 11 percent and reduced absolute load recorded with the data logger indicates the A/C was turned off during the Bully Dog SC03 test. ERG was not present during this test on 10 November 2015 to confirm but was present for the baseline test on 28 October 2015 when it was turned on per the SC03 test procedure.

³⁷ SAE J1979 parameter PID\$04

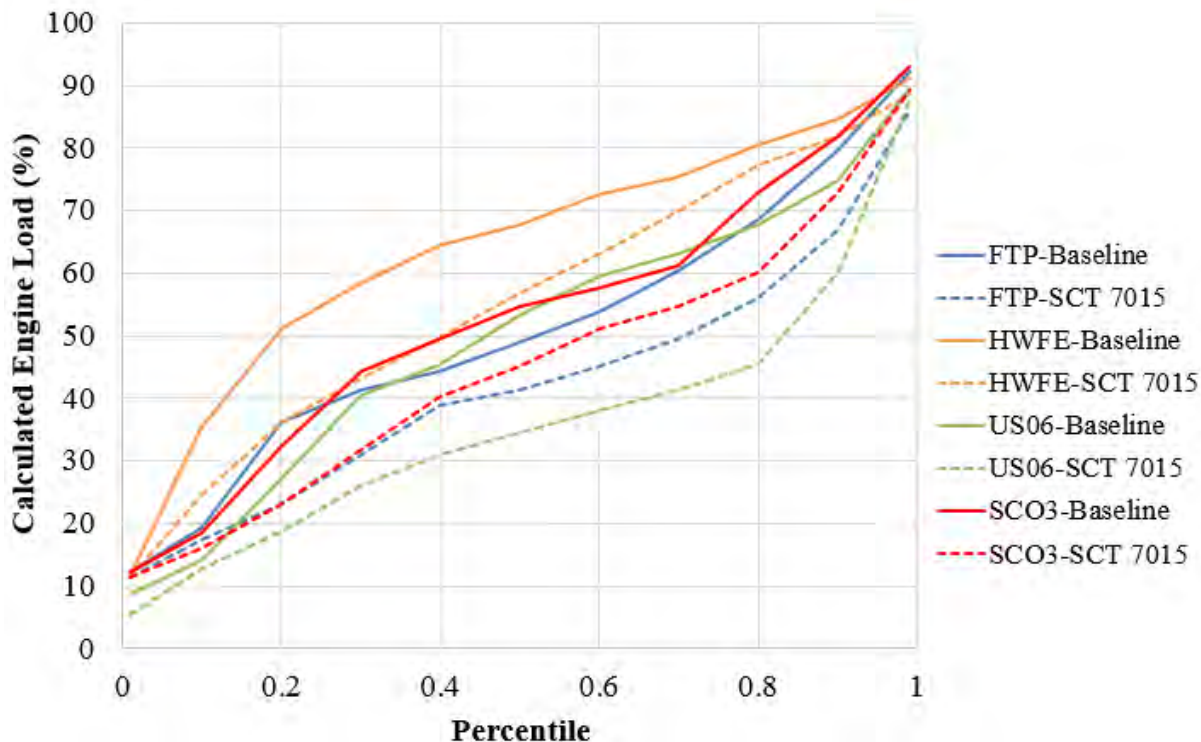


Figure 13. Calculated Engine Load (percent) Data Logged from the F-150 Test Vehicle

a. Long-term Fuel Trims

The long-term fuel trim parameter³⁸ represents the percent change in long-term fuel trims (i.e., a positive value is a change to more fuel input, a negative value is a change to less fuel input). As shown in Figure 14, the data show that there was a significant decrease in long-term fuel trim with the Bully Dog 40420 tuner installed on all tests. As fuel trim represents a change in injector duration (and, hence, volume of fuel provided to the engine), a change in a vehicle's fuel trim may affect emission control performance and the longevity of emission control components, in particular the catalytic converter.

³⁸ SAE J1979 parameter PID\$07

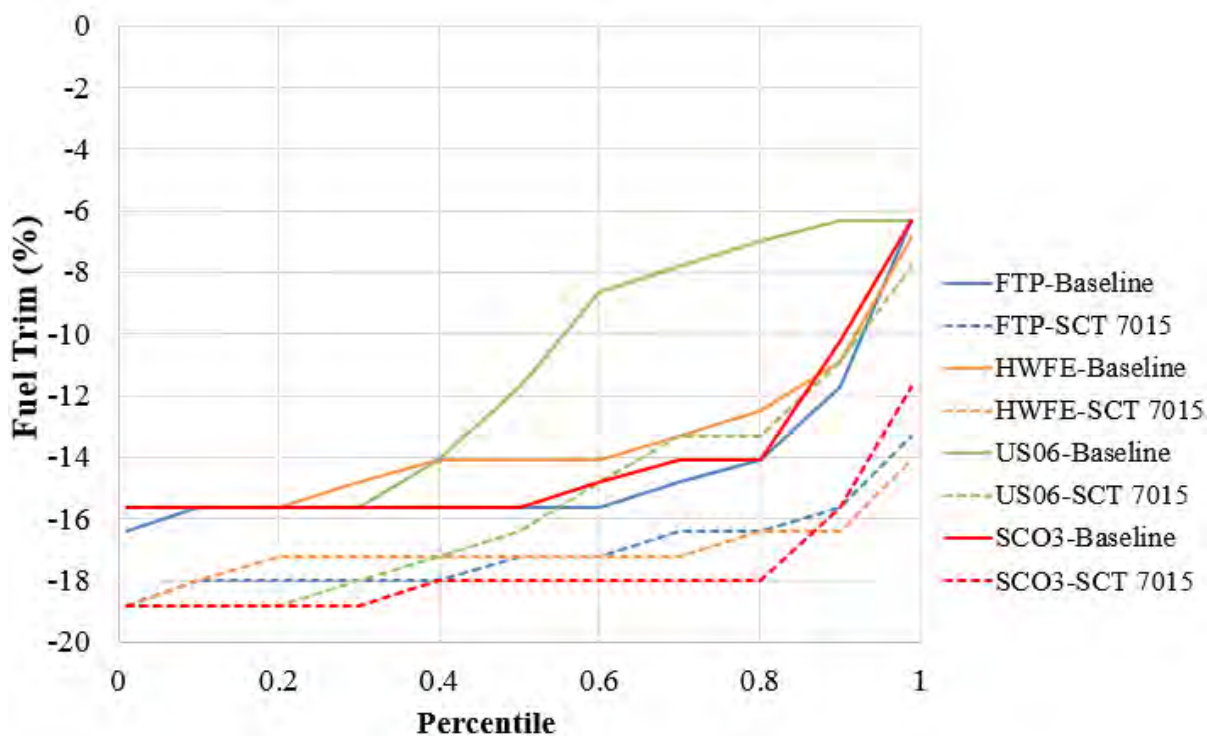


Figure 14. Long-term Fuel Trim (percent) Data Logged from the F-150 Test Vehicle

C. Measured Emissions Results

The following sections summarize the results from emissions testing at EPA’s testing facility using a chassis dynamometer. Table 8 and Table 9 in Section III.C (Quality Assurance and Other Documentation) discusses dynamometer calibration settings, test identification numbers, and other information documenting the emission results discussed in this section.

1. F-250 – 6.7 Liter Ford Powerstroke

Table 14 summarizes the baseline (i.e., stock calibration) emission results for the F-250 test vehicle and the results with the Bully Dog 40420 tuner installed. As described in Section III.B.1.a, ERG kept the tuner in the “extreme” shift on-the-fly power level at all times when the tuner was installed on the F-250. EPA measured CO, CO₂, NO_x, NMHC, particulate matter (PM), and calculated fuel economy for each calibration on the FTP, HWFE, US06, and SC03 drive cycles. Results are presented in Table 14. The emissions results are organized by test and calibration. The certified emission levels for this particular engine family are also provided. Additional details on emissions testing and results are provided in Appendices D.

As shown in Table 14, EPA measured 0.295 grams of NO_x per mile on the FTP test with the Bully Dog 40420 tuner installed. This is greater than the applicable standard of 0.2 grams per mile for this engine family set forth in 40 CFR Part 86 and is nearly three times higher than the measured value from the baseline (i.e., stock calibration) FTP test (0.107 grams per mile). When Ford certified this engine family, they measured 0.12 grams of NO_x per mile on the FTP test and certified it at 0.2 grams per mile after applying the appropriate adjustment factors (i.e., deterioration and EAF, See Section III.A). Increases in NO_x emissions over the HWFE and US06 tests were also observed with the Bully Dog 40420 tuner installed but there are no applicable exhaust standard for this engine family on those tests.

Table 14. FTP Emissions Results for MY 2012 F-250 with a 6.7 Liter Powerstroke Diesel Engine with the Bully Dog 40420 Tuner (Extreme Setting)

Test	Measured Results ^a (g/mi, unless otherwise noted)				CFMXD06.761A Cert. Information (120,000 miles) ^b				
	Pollutant	Baseline (i.e., stock)	BD Extreme	Percent Change	Measured FTP Result (new vehicle)	Upward EAF	DF	Useful Life Cert. Level	Useful Life Cert. Standard
FTP	CO	0.689	0.904	31%	0.35000	0.01000	0.2100	0.6000	7.3
	NO _x	0.107	0.295	177%	0.12000	0.01000	0.0500	0.2000	0.2
	NMHC	0.071	0.100	41%	0.03280	0.00110	0.0192	0.0530	0.195
	PM ^c	0.000154	0.000317	106%	0.00500	-0.00010	0.0050	0.0100	0.02
	FE (mpg)	14.13	14.46	2%	N/A - No standards apply for this vehicle and test				
HWFE	CO	0.014	0.015	7%					
	NO _x	0.009	0.036	300%					
	NMHC	0.004	0.000	-100%					
	PM	0.00020	0.00030	53%					
	FE (mpg)	23.43	23.62	1%					
US06	CO	0.018	0.019	6%					
	NO _x	0.199	0.442	122%					
	NMHC	0.001	0.000	-100%					
	PM	0.00053	0.00025	-53%					
	FE (mpg)	16.92	17.64	4%					
SC03	CO	0.026	0.034	31%					
	NO _x	0.649	0.630	-3%					
	NMHC	0.009	0.008	-11%					
	PM	0.00088	0.00094	6%					
	FE (mpg)	14.08	15.59	11%					

Red – FTP NO_x emission levels exceeded the applicable standard to which this engine was certified with the Bully Dog 40420 tuner installed.

Orange – Observed increases in NO_x on the HWFE and US06. However, there are no applicable exhaust standard for this engine family on those tests.

Blue – Fuel economy increased by 11 percent and reduced absolute load recorded with the data logger indicates the A/C was turned off during the Bully Dog SC03 test. ERG was not present during this test on 10 November 2015 to confirm but was present for the baseline test on 28 October 2015 when it was turned on per the SC03 test procedure.

a – All results are rounded to three decimal places unless fewer decimal places were reported in the Appendix D laboratory test reports. PM results are rounded to six decimal places because of the raw results were in milligrams per mile and ERG converted them to grams per mile.

b – All engine certification data, including the number of decimal places, are shown as reported by OTAQ (<http://www3.epa.gov/otaq/documents/eng-cert/on-hwy-2012b.xls>).

c – Despite the large increase in PM on the FTP test with the Bully Dog tuner installed compared to stock, all PM results are well below the useful life standard.

1. F-150 – 3.5 Liter Ford EcoBoost

Table 15 summarizes the baseline (i.e., stock calibration) emission results for the F-150 test vehicle and the results with the SCT 7015 tuner installed. EPA measured CO, NO_x, NMHC, and fuel economy for each calibration on the FTP, HWFE, US06, and SC03 tests. The emissions results are organized by test and calibration. The certified emission levels reported by Ford for this particular engine family are also provided. As shown in Table 15, none of the measured emissions exceeded certification standards with the SCT 7015 tuner installed.

Table 15. Emissions Results MY 2013 F-150 with a 3.5 Liter EcoBoost Gasoline Engine with the SCT 7015 93 Octane Performance Tune

Test	Results (g/mi, unless otherwise noted)				DFMXT03.54DX Cert. Info. (50,000 miles)				DFMXT03.54DX Cert. Info. (120,000 miles)			
	Pollutant	Baseline	SCT 93 Octane Perf.	Percent Change	Measured FTP Result (new vehicle)	Upward E/AF	DF	Useful Life Cert. Level	Measured FTP Result (new vehicle)	Upward E/AF	DF	Useful Life Cert. Level
FTP	CO	0.536	0.578	8%	0.68	0.25	0.9	3.4	0.68	0.63	1.3	4.2
	NO _x	0.017	0.023	36%	0.008	0.004	0.01	0.05	0.008	0.011	0.02	0.07
	HMHC	0.024	0.023	-7%	0.0262	0.01	0.036	0.075	0.0262	0.0251	0.051	0.090
	FE (mpg)	15.57	15.65	1%	N/A - No standards apply.							
	CO	0.063	0.108	71%	N/A - No standards apply.							
	NO _x	0.004	0.005	25%	0.003	0.004	0.01	0.07	0.0028	0.011	0.014	0.090
HW/FE	HMHC	0.001	0.002	100%	N/A - No standards apply.							
	FE (mpg)	23.85	24.14	1%	N/A - No standards apply.							
	CO	1.02	8.75	762%	N/A - No standards apply.							
US06	NO _x	0.107	0.053	-50%	N/A - No standards apply.							
	HMHC	0.020	.054	170%	N/A - No standards apply.							
	FE (mpg)	17.54	17.23	-2%	N/A - No standards apply.							
SC03	CO	0.856	0.545	-36%	N/A - No standards apply.							
	NO _x	0.060	0.056	-7%	N/A - No standards apply.							
	HMHC	0.015	0.013	-13%	N/A - No standards apply.							
	FE (mpg)	15.26	15.27	0%	N/A - No standards apply.							

Blue – Tailpipe backpressure outside the allowable 5" H₂O pressure draw; results cannot be validated.